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THE IONIZATION OF THE AIR.

The well-known facts that the layer of air close to the earth is always more or less ionized and that the earth itself contains radioactive materials practically everywhere lead to the suggestion that it is the radiation from these substances in the earth that brings about the ionization of the neighboring air. This theory is not accepted by Mr. W. W. Strong, who gives his reasons for rejecting it in a recent issue of *Terrestrial Magnetism and Atmospheric Electricity*. By a careful study of the change in ionization throughout the day and year, and the effect of various atmospheric phenomena upon the ionization, he is led to the conclusion that this ionization is due to a radioactive substance in the air itself.

In the first place, Mr. Strong points out that several investigators have shown that the ionization taking place in closed vessels varies considerably in amount in the course of two or three days, while if this effect were due to the penetrating, or gamma, radiation from the earth it would be constant. Moreover, it is found that immediately after a rain or snow the ionization of the air is considerably reduced, but as soon as the storm is over it increases again at a rapid rate. This also is in agreement with the suggestion that the ionization is due to a material in the air which is carried to the earth by the rain or snow.

In order to check in another way these effects of the earth, Mr. Strong studied the action of an electroscope in the Cumberland Valley, where the limestone is known to contain radioactive substances. By watching the behavior of this instrument throughout the day, for several days, both when placed in the air and when submerged in a cistern four feet below the surface of the water, he found that the ionization in the latter case was practically constant, while in the former it varied in a characteristic way. The value was least at night and rose rapidly during the morning, as the sun warmed the earth, to a maximum value in the middle of the day, falling again toward evening. This could not be explained if the radiations were due to substances within the earth.

The explanation Mr. Strong gives is that the actual ionization of the air is due to the radioactive material, probably an emanation, in the air, and that this emanation is itself given off by the solid radioactive materials of the ground. During the disintegration of these materials, which results in the liberation of this emanation, the penetrating of gamma radiation is not observed, but when this emanation itself disinte-

grates, the gamma ray appears and thus brings about the effect upon the air.

It is rather interesting to consider that these remarkable reactions are going on about us continually, although we knew nothing at all about them until very recently. It is probable that the fact that they have been ever present is one reason why they were not previously noticed. It seems also likely that these reactions play a more important part in nature's operations than we at present realize.

THE WEATHERING OF COAL.

A feature of the operation of large electrical systems, which depend upon coal as a source of power, is the storage of a sufficient amount of fuel near at hand to eliminate the possibility of a shutdown due to any cause which would prevent the railroads or other systems of transporting from supplying the power stations with their daily needs. This feature has become vitally important in those cities where so much depends upon the continuity of the electrical supply; and, moreover, there are certain economic features well worth securing. When the fuel can be ordered at those times when the price is most favorable, and in large quantities, a considerable saving in the annual expense for coal may be made. Such systems of securing the fuel supply necessitate some system of storage, and this is usually in open yards with no protection from the weather. In fact, when enormous quantities are to be stored, the expense of putting it under roof would be very great.

It has been known for some time that coal stored in this way undergoes a weathering process, but not much attention was paid to this fact until the last few years, when the power companies began to put away, during the spring and summer, large supplies of coal for use later on. Reports upon this weathering effect have differed somewhat, as would naturally be the case, due to the different conditions under which the investigations have been made, but they showed a loss in heat value varying from two to ten per cent. Such losses are important when it is remembered that the cost of fuel is the main item in the operating expense of the station, and hence further light upon the subject is very desirable, not only in order to give a more definite idea of just what loss should be reckoned on, but as a possible means of throwing some light upon the subject which would enable the loss to be diminished. One proposal made some years ago, and, in fact, tried in one or two instances, was that the coal would deteriorate less if stored under water, and is thus protected from the air, but up to the present time, while this method is reported to be good, it has not seemed applicable for storing large quantities. More definite information regarding the effectiveness of this method of protection is also much to be desired.

With these important questions in mind, the report contained in a bulletin which has been published by the Engineering Experiment Station of the University of Illinois is most acceptable. This contains two studies; one dealing with the weathering of coal, which has been prepared by Professor S. W. Parr, of the Department of Applied Chemistry, and Mr. N. D. Hamilton; the second report, submitted also by Professor Parr, assisted by Mr. W. F. Wheeler, deals with the deterioration of coal samples, a subject which would at first seem not to be of such immediate interest to the engineer. But when it is remembered that the coal supply is often bought on a specification based upon its heating value, and samples of it may be kept in order to check at a later date any previous analysis in order to determine a disputed question which may involve a large sum of money, the problem of preserving the original samples unchanged becomes important. This question will be returned to after the results of the first investigation have been pointed out.

In taking up the study of the weathering of coal, Professor Parr first gives a brief synopsis of previous opinions upon this question. These have been gathered from all over the world and cover a period of about forty years. The summary of opinions does not give any very definite idea of what actually is the case, but there is agreement that the effect depends upon the kind of coal, and particularly on its volatile components. The presence of occluded inflammable gases in the coal, both before and after mining, affects the action, as also does the presence of pyrites or other compounds of sulphur. Naturally the weathering effect depends also, in some degree, upon the size of the coal and the accessibility of oxygen; and the presence of moisture to a greater or less degree, and also the temperature might have something to do with the chemical changes which go on. From the evidence obtainable, there is little doubt that the lignitic, bituminous and semi-bituminous coals, which have a relatively high amount of volatile combustible matter, have a greater tendency to weather than the anthracites, where the volatile matter is low. It is well known that slack coal is more liable to spontaneous ignition and to the deteriorating influence of weathering agents. Finer coal not only is more accessible to oxygen, but will hold moisture the longest. It was to obtain more definite figures on these various effects that the work was begun. The present report, it may be said, is only preliminary, but it gives a good deal of information respecting the behavior of the Illinois coals. The object of the research was to test the effect of outdoor exposure, exposure to a dry atmosphere at a somewhat elevated temperature, the effect of moisture at the same elevated temperature, and the protecting effect of ordinary water at a temperature of approximately seventy degrees Fahrenheit. Nine lots of coal were put through these tests, the investigation lasting for a period of nine months, samples being analyzed at the beginning of the test and after five, seven and nine months' exposure. In every instance the samples were analyzed and their calorific values determined. The first evidence of the test is the noticeable effect of submerging the coal. The values found for the submerged coal throughout the nine months hardly varied at all by greater amounts than might be found from two tests made on succeeding days by the same operator.

This result may be compared with the effect of exposure to the weather, which was done by placing the samples in shallow

boxes on the flat roof of a building, where they were left from October until the succeeding July. The various samples of coal showed different tendencies to crumble, and it was found that the loss which took place varied from two to ten per cent. The loss takes place most rapidly during the first months of weathering. This contains a hint that when old supplies are on hand it may be better to allow them to stand and to use the new supply, and in this way save the loss which would occur in the latter in the first few months of weathering.

The results obtained from the samples of coal exposed to a thoroughly dry, warm atmosphere are striking. In fact, these samples lost about as much as did those exposed to outdoor conditions. This result seems to indicate that the effect of moisture is slight, and hence the amount of protection which would be secured by putting the coal storage under cover is of little value. There is a loss due directly to the moisture if the coal contains sulphur, but this is so small that it is negligible when compared with the more serious loss of volatile hydrocarbons. In other words, weathering is not a leaching process. It seems to be a direct loss of the volatile components.

The results of this preliminary study plainly indicate, then, the value of storing the Illinois coals under water, and that it is not worth while, when this can not be done, to put them under cover. If large supplies of these coals are on hand, the older samples have practically reached a stable condition and will not deteriorate further, or at any rate slowly. It is the new supplies that suffer from the process.

Returning to the question of preserving samples of coal, probably the commonest way of doing this is in a preserving jar with a cover which screws on, that known as the Mason jar being very generally used. It happens that Professor Parr had stored samples of coal in jars of this kind and also in a jar the top of which was held down by a wire clamp. He found that the samples in the Mason jars changed with time, the change being enough to affect considerably the estimate of the value of the coal. When the samples were stored in the tighter jar there was also some change in the coal, and it was also found that gas was given off which would ignite. But this change is comparatively slight and takes place but slowly. It indicates, however, that either the hydrocarbons are given off directly by the coal when it is removed from the mine, or that gases occluded by it bring about this deterioration. The samples should, therefore, be stored in hermetically tight vessels, the ordinary Mason jar not being satisfactory. These deductions all apply to the light Illinois coals, but there is no doubt that similar results will be found, in a greater or less degree, in other bituminous or semi-bituminous coals. The results of these further investigations will be awaited with much interest. The matter is of considerable importance, not only to the electric power companies, but to many other industries which use large quantities of coal and which might find it profitable to buy it when the price is down and store it for future use.

ELECTRICAL POWER IN FARM WORK.

Perhaps we should not be surprised at the slow progress of electrical application to farming work, yet it is a little strange that in this country, which is so largely agricultural and which is so abundantly provided with water powers, almost nothing has been done, and to find typical examples of what might be accomplished it is necessary to go abroad, to France or Germany. Over there, in a few cases at least, some serious attempts to do the work on the farm by means of electric power have been made, and although distance often lends enchantment to descriptions, the reports which have been published do not intimate that the results were not at least as favorable as had been expected.

It is probable, however, that within a few years, when the development of our water powers has advanced considerably and power companies are looking for desirable customers, they may attempt to build up a business among the farmers. It can hardly be expected that the farmers will themselves be the first to make a decided movement in this way. As a rule they are conservative and inclined to follow the methods their fathers used. They are accustomed to the horse and are apt to consider at length any plan which calls for a considerable outlay for equipment. It will be for the power companies to point out the advantages of other methods and to show in what way a change would be profitable.

The one great advantage of the horse is what might be called its flexibility. He is a self-contained, self-propelling prime mover. This fact is apt to overshadow his decided shortcomings in other ways. He is costly to keep; he requires constant attention, and is expensive as a source of power. His rate of working is low, and when it is sought to increase the power by placing a number of units in a team, the system becomes awkward and difficult to handle, and, besides, soon reaches a point where more men are required to control the work. Practically all the work of the farm can be done, and is now being done, by portable electric motors, which require only a fraction of the attention which must be given to the horse, at a much less cost for power or feed. As a means for hauling heavy loads to market the horse is not cheap, and in some sections of the country the automobile is already displacing him in this work. Besides these disadvantages, if the horse should be replaced by the motor this would free a considerable part of the farm, which must now be given up to raising hay and feed for him, for more profitable crops.

It would seem that the South and the Pacific Coast offer good fields for a trial of farming by electric power. In both of these sections the farms are large and the crops such as might be conveniently cultivated by the motor, and these states are also rich in water powers which are now being developed. It would certainly be disappointing if the benefits resulting from the utilization of water power are limited entirely to the city and the factory and the farms are left to struggle along as they have done since time began.

Patent Office Squabble.

N. W. Burton, a Patent Office examiner; Henry E. Everding, a Philadelphia lawyer, and John A. Heany, an inventor, of York, Pa., were arrested in Washington, D. C., on February 27, on an indictment charging them with conspiracy to destroy government records and to defraud. The indictment alleges in substance that they were engaged in a plan to steal the work of inventors of electric lighting devices. It is claimed that they gathered in for Heany's benefit the ideas of other electrical experts working upon this development.

Substantially the plan of operation is alleged to be as follows: Heany filed application for a patent on filaments and electrodes for incandescent and arc lamps. Burton, it is charged, held up applications filed by other men for similar appliances, and furnished details of what they contained to Heany. He then notified the defrauded applicants that their claims were already covered in the applications filed by Heany. The matter was called to the attention of Assistant District Attorney Adkins by Secretary Garfield some time ago, and has been under investigation by the Grand Jury. The three men were summoned before the Grand Jury on February 27, and upon the conclusion of their testimony the indictment was returned. The affair has caused a considerable stir as the parties involved are well known in the industry, and Mr. Heany is well known in York, Pa., and has been prominently identified with interests there for some time.

Commissioner of Patents E. B. Moore makes the following statement in connection with this case:

"The report of that committee finds, in substance, that by the connivance of an employé of the Patent Office, matter that was not in the application for the patent at date of filing was unlawfully introduced subsequently during its prosecution, thereby laying a foundation for claims to an inventor not disclosed in the application when it was filed.

"The effect of such an act is to establish a false date of invention, much earlier than the true date thereof, and thus enable the patentee to dominate and control all inventions falling within the scope of the patent.

"The invention involved is thought to be very valuable, and a great advantage would attend it if a date of invention sufficiently early to antedate the prior invention of others could be secured. To be successful in this plan it was necessary to destroy original records of the office and file substitutes therefor, and by changing the dates of receiving stamps make it appear that such substitute papers were in fact actually filed upon the fictitious dates stamped on the papers.

"Notwithstanding the vast moneyed interests involved in patents and the consequent many opportunities for corruption arising therefrom and from the necessity of relying upon the integrity of each individual examiner, owing to the technical and judicial character of the work of the Patent Office, no examiner had ever been shown false hitherto to the trust imposed upon him in all the 118 years of existence of the United States patent system."

Changes in the New York & New Jersey Telephone Company.

At the annual election of officers of the New York & New Jersey Telephone Company, held in Brooklyn, N. Y., on February 27, Theodore N. Vail was elected chairman of the board of directors. Union N. Bethell was re-elected president; W. D. Sargent was re-elected vice-president; H. F. Thurber, formerly general manager, was elected second vice-president; Waldron Hoppins was re-elected secretary, and Ford Huntington, treasurer of the New York Telephone Company, was elected treasurer in place of H. S. Snow, resigned. Walter Brown was elected auditor in place of J. L. Hamar, who will serve the company in another capacity. John C. Reilly, who has been with the company for twenty-five years as general superintendent, general manager and vice-president, resigned as vice-president and will assume important duties assigned by the president. These changes are in line with matured plans, and are not the result of the recent discovery of irregularities in the office of the treasurer. Other minor changes in the routine of the accounting and collection departments will occur in completing the organization.

Illuminating Engineering Society.

The New York section of the Illuminating Engineering Society will hold a meeting in the Engineering Societies Building, New York city, on Thursday evening, March 12, at 8.15 o'clock. A paper will be presented by E. L. Elliott, entitled "The Relation of Illuminating Engineering to Architecture from the Engineer's Standpoint."

New Interborough Bonds.

It is understood that an issue of part of the proposed $50,000,000 Interborough Rapid Transit Company bonds will shortly be placed before the public. At the close of its last year the company had a surplus for the year of $682,000 after the payment of the seven-per-cent dividends on Manhattan stock, nine-per-cent dividends on its own stock, and all charges and taxes. The surplus for the year was an increase of $169,000 over that of the previous year, but gross earnings showed a greater increase, for the reason that the charges increased by more than $1,000,000. About a quarter of this increase was due to increased payments on account of the new Manhattan stock issued in 1906. As a result of the opening of the Brooklyn tube it is said the passenger travel on the subway has increased from 40,000 to 50,000 a day, producing an additional revenue of from $2,000 to $2,500 daily. On the other hand, the increase in operating expenses is but $500 a day. Even better results are expected when the extension to Atlantic avenue, Brooklyn, is completed. It is proposed to secure the forthcoming five-per-cent bonds by a first mortgage on the power-houses and rolling stock, on the Steinway tunnel and on the Long Island traction properties owned by the company. The company has two series of notes outstanding, one of $15,000,000, maturing May 1 next, and the other of $10,000,000, maturing March 1, 1910. It has a floating indebtedness of $5,000,000. It is the intention of the company to sell $20,000,000 of bonds and use the proceeds to retire the $15,000,000 of notes maturing on May 1, and the $5,000,000 floating indebtedness, if bond market conditions are favorable; otherwise the bonds will be issued as collateral security for a new issue of notes.

Western Electric Company Election.

At a meeting of the board of directors of the Western Electric Company, held in Chicago, Ill., on February 19, two changes were made in the board: H. A. Halligan and J. W. Johnson resigned. They were succeeded by J. I. Waterbury, of New York, and W. H. Miner, of Chicago. The officers were re-elected as follows: President, Enos M. Barton; vice-president, Harry B. Thayer; secretary, H. A. Halligan; assistant secretaries, R. H. Gregory and W. S. Gifford; treasurer, F. V. Bennis; assistant treasurers, E. H. Gilmore and John Bray.

International Exposition of the Applications of Electricity.

The International Exposition of the Applications of Electricity, organized under the auspices of the city of Marseilles, the Department de Bouches du Rhône and the Chamber of Commerce, will be held in Marseilles, France, from April 19 to October 31. In order, however, to allow more time for American exhibitors, the American section will not be opened until June 1.

The exposition will be located in the park of the Rond Point du Prado, and will receive any machinery, apparatus and instruments, as well as industrial products, relating to the utilization of electricity. Special exhibits of fine arts, horticulture, automobiles, etc., will also be arranged.

The exposition will comprise the following principal groups, which will be further subdivided into classes: (1) transmission, distribution and generation of electrical energy (this group will also include steam and water turbines, steam engines, boilers and all forms of prime movers); (2) applications of electricity to industries in general; (3) applications of electricity to domestic industries; (4) applications to domestic economy; (5) applications to public and private lighting; (6) applications to heating and ventilation; (7) applications to machinery for lifting and manipulation; (8) applications to mines and quarries; (9) applications to transportation; (10) applications to agriculture; (11) applications to military and naval engineering; (12) electrochemistry, electrometallurgy and the allied sciences; (13) telegraphy and telephony; (14) applications to the medical and surgical sciences; (15) electrical instruments for measurement and calibration; (16) raw materials and manufactures used in electrical industries; (17) practical and theoretical teaching of the science of electricity; (18) miscellaneous industries and their products.

The exposition will be governed by two general commissioners appointed by the President.

An international congress of all applications of electricity will be held from September 14 to September 21.

The American Honorary Committee is headed by Jules Jusserand, French Ambassador at Washington; H. G. Stott, president of the American Institute of Electrical Engineers, and C. P. Neill, United States Commissioner of Labor. Paul Dieny is commissioner for the United States, with headquarters in the Park Row Building, New York city. The other members of the American Honorary Committee are as follows: Bion J. Arnold, H. G. Bayer, C. H. Becker, Lucien Bonzom, C. F. Brush, J. J. Carty, Maurice Coster, Professor F. B. Crocker, Dr. Lee de Forest, Carl Hering, Dr. Peter Cooper Hewitt, Samuel Insull, Pierre Kamperdyk, C. W. Kohlsaat, Etienne Lanel, H. Ward Leonard, J. W. Lieb, Jr., C. O. Mailloux, T. C. Martin, R. W. Pope, Dr. Henry Noel Potter, Dr. C. P. Steinmetz, L. B. Stillwell, Frank J. Sprague, Dr. Elihu Thomson, Dr. W. H. Tolman, Dr. S. S. Wheeler, W. J. Wilgus, the Hon. Carroll D. Wright, and Arnold von Schrenk, assistant commissioner for the United States.

The Morse Electric Club.

The Morse Electric Club gave its initial dinner at the Hotel Breslin, New York city, on Saturday evening, February 29, some 200 being present. The guest of honor was Colonel Robert C. Clowry, president of the Western Union Telegraph Company, and J. B. Van Every, the president of the club, was the capable toastmaster. There were a number of speakers, among whom were Colonel Clowry, E. T. Jeffery, W. J. Dealy and I. N. Stevens.

Before adjournment all present united in a toast to Thomas A. Edison, and a wish for his speedy return to perfect health.

The club's membership is composed largely of the officials and men of the Western Union Telegraph Company, and a large number of out-of-town superintendents and managers were present.

The officers of the club are: President, J. B. Van Every; vice-presidents, J. C. Barclay and B. Brooks; secretary, F. J. Scherrer; treasurer, R. J. Murphy.

Among those present were: Henry D. Estabrook, James Kempster, Charles W. Price, Henry L. Shippy, R. D. Brixey, B. Brooks, P. J. Casey, J. J. Ghegan, William H. Hearst, A. F. Kelley, Frederick Pearce, W. E. Paine, J. B. Taltavall, H. F. Van Every and M. T. Wilbur.

American Institute of Electrical Engineers.

The next regular meeting of the American Institute of Electrical Engineers will be held on Friday, March 13, at 8 P. M. A paper by L. B. Stillwell and H. S. Putnam, entitled "Notes on Electric Haulage of Canal Boats," will be presented. This will be illustrated by lantern slides.

Mr. Edison's Condition.

The recovery of Thomas A. Edison is said at the Manhattan Eye, Ear and Throat Hospital to be now practically assured. The fever which set in immediately after the operation for mastoiditis on February 23 has disappeared entirely, and fears are no longer felt that complications may develop. It is now thought that Mr. Edison will be confined to the hospital for but a few days longer.

Accept Westinghouse Terms.

At a meeting, on February 28, at Pittsburg, Pa., of the committee of creditors of the Westinghouse Machine Company, it was decided to take the property out of the hands of the receivers at once. The creditors' committee, representing Boston, Philadelphia, New York and Pittsburg interests, was unanimous in its vote to accept the plans for reorganization and extension which were submitted on December 24. By the terms of the agreement creditors whose accounts do not amount to $500 will be paid in cash; while those holding larger than $500 claims will accept a $500 bond for each $500 they claim, the excess over a $500 multiple to be paid in cash. The bonds are to run for three years and bear six per cent interest. There will be arranged for on these terms about $7,000,000 of debts.

Appreciation of General Eugene Griffen.

At the recent regimental dinner of the First Volunteer Engineers, held shortly after the death of General Eugene Griffen, who had been the commanding officer, he was feelingly remembered by those present. Among others, the appreciation expressed by Dr. Louis Duncan of his former officer was much admired, and several requests for this have since been made of Dr. Duncan. It is as follows:

"We knew the strength of his patriotism. We knew his stern devotion to duty, and we knew the delicacy and tenderness of his friendship. In him there was no small or ignoble thought.

"Whether we who are here believe in any creed, or whether our souls are shrouded in the gloom of disbelief, this we know, that somewhere within the illimitable boundaries of space we shall meet him again. God judges his people outside of creed or belief.

"Eugene Griffen was a good man and no harm can happen to a good man whether he be alive or dead."

AERIAL AND UNDERGROUND CONSTRUCTION.[1]

BY C. H. JUDSON.

A few years ago advanced telephone engineers were writing long arguments to prove the superiority of ærial cable over open-wire construction. It was shown that a pole line carrying fifty pairs of open wire would cost a great deal more both to erect and maintain than a fifty-pair cable line, and it was confidently predicted that within ten years there would be no more open-wire construction where twenty-five pairs or more of wires were required. The ten years have not elapsed, and it is at least five years since the all-cable idea got a firm foothold, and any engineer who would plan an open-wire lead of more than ten pairs in city work at the present time would be considered just a trifle of a back number. Indeed, the general tendency to get rid of all open-wire work has almost caused the cross-arm to vanish from urban field. The advance from open wire to cable was a long one and many telephone men thought that their real troubles were at an end when they got all their wires cased up in impervious lead pipes, so they leaned back and took deep breaths of satisfaction. They had put the outlying lines in as good condition as those close to the exchange—those which they had buried under the streets. They had buried these principally because the municipal authorities would not permit poles in the business district or because the cables were so many that no pole line would carry them.

The relation between the maintenance charges against open wire and cable on poles had been worked out, discussed and proven an uncontrovertable fact by a battle of argument and test, and the cables were so far the winners in the contest that there was no question as to the desirability of installing them. The cables were easily the favorites, and in the debate no one cared to hear anything to their discredit, and, so long as the open wire was as good as down and out in the first round, it had no champion to call in question the statements of the cable advocates. This was probably the best thing, else an important step ahead might have been delayed. From open wire to cable was a wise move and made greatly toward better service and better earnings all along the line.

Now comes the next step. The telephone line put off its swaddling clothes with the open wire and now it is looking for trousers and boots. You can not keep a growing boy in dresses long, and the pole line can not last forever. Some day it must come down, and it were better not to build it at all than to build it for a day. If the pole line will not take care of the cable lead we must go underground. Not only is the conduit the next step beyond the messenger, but it is, so far as present knowledge goes, the ultimate. But the ultimate stage is not adapted, for business reasons, to all portions of the construction. Much of this is still in the baby stage and must wear baby clothes. But the child grows faster nowadays than he did when the business was new, and is likely to become a man over night. The aim, then, should be to adapt the construction not only to immediate needs but to the requirements of the near future.

That underground cable installed in properly-built conduits is without exception the best method of distribution for telephone wires is axiomatic. Your engineer does not have to be told that wires so installed will give the maintenance department less sleepless nights and show better on the department's pay-roll than the cables or wires installed in the air. This is a primary principle in modern telephone engineering, and while application of this principle will produce ideal results, it presupposes ideal conditions both as to the demand for service and the ability of the financial end of the proposition to meet the bills for such construction. As no telephone plant has ever been built under such ideal conditions, and as it is not at all likely that they will ever exist throughout the entire distribution of a system, your engineer is compelled to meet the endless variety of conditions which are far from the ideal, and which arise both from his inability to know what the demand is going to be and from the inadvisability of expending the amount of money requisite to the installation of a technically perfect plant. He is therefore compelled to make such modifications of this plan as will judiciously conserve the forces at his command and meet the requirements of the future as he may to the best of his ability foresee them.

If your engineer can look forward for five years and can determine about what sort of construction he is going to require in a rapidly-growing territory at the end of that time, he is a seer of the first magnitude, and yet his intuition tells him that to give his company the best results he must put on his strongest magnifiers and look with aching eyes to see, if possible, however dimly mayhap those conditions.

Granted that the engineer has made his calculations and looked into the future as he should and has figured on what his necessities are going to be five years hence, he is ready to take his maps in hand and put down upon them the conventionals that shall indicate his underground and his ærial leads. Right here, however, he runs up against other propositions. It may be that streets are unimproved; that grades are not established; that the question of branch exchanges established arises. These cut considerable figure, for he would not think of going into an expensive underground proposition with the possibility of having to remove it within ten or fifteen years, and with the probable establishment of branch exchanges he would realize the necessity of putting down within a reasonable time some of the extensive leads and of reducing them to trunk lines. All of these things having been carefully worked out, he now determines where his underground must be permanently established. He has long before this figured out the cost of his underground work. He has calculated the cost of ærial construction. He knows to a nicety what difference is between the cost of an underground and the cost of an overhead lead carrying the same number of wires in cable, and with all the other facts before him he takes his drawing pen and makes up his preliminary maps. He then prepares his estimate and makes the necessary calculations to prove the ultimate efficient earning capacity of each lead; that is, presuming that he is endeavoring to make every portion of the work a valuable asset.

It usually happens that some portion which in the preliminary survey seemed to require preparation for great growth, in the finished plan has an entirely different aspect, and the reverse may be the case in another part of the work. Again, to decide on the precise nature of the work for a given lead may require much careful thought, the use of some mathematics, and, as I have already said, not a little prophetic vision. But with all this careful calculation few engineers have ever been able to install as much underground conduit as they wish in any plant, for the reason that the engineer is usually influenced by the state of the treasury, and in the independent telephone business the treasuries, however liberally provided, have rarely been able to keep up with the

[1] Abstract of a paper read before the International Independent Telephone Association, Chicago, Ill., January 21-23, 1908.

demand for service. So the problem becomes still more difficult of solution. Then it becomes a question of putting the money at hand where it will do the most good. Such a course naturally is destructive of even modified ideals, but your engineer, if he is faithful and skilled, will not permit ideals to clog his business instincts, and, with a view to the dividends which his company is going to pay, he makes his plans to meet the situation in which he is placed.

For the purpose of comparison let us take a case where we absolutely require 100 pairs in a lead a mile long, and let us make a rough calculation of the cost of a mile of four-duct conduit with the necessary manholes and distributing poles, and a mile of forty-five-foot poles carrying two one-half-inch Siemens-Martin messengers, and with distributing poles in the same positions as the underground system. For the purposes of simplifying the illustration we will imagine the full cables running the entire mile and figuring that the ærial lead will be all in cable.

Taking eighteen cents per duct foot as a reasonable average figure for the installation of the underground work at $75 apiece for the manholes, a mile of conduit as mentioned will cost approximately $5,300, while a mile of the poles and messenger and everything complete will cost in round numbers $2,200. These are average figures and made from costs taken from a number of different construction jobs recently completed in different parts of the country. Now there is a difference here in this construction of approximately $3,100 and the lines are ready for the cable.

We can install 400 pairs easily, and 600 pairs if necessary, on the two strands which we have erected. If we put the 600 pairs on, it is not likely that we will want to put much more on the same poles, although the poles could probably be expected to carry 200 pairs in addition if desired, but we all know the results of overloading poles with heavy cables in most parts of the country. Our underground conduit, however, has a capacity of four cables, and we can put as high as 2,000 pairs in the conduit if desired.

The maintenance and depreciation charges against our mile of pole line will be somewhere in the neighborhood of $242 per annum, figuring on one per cent for maintenance and ten per cent for depreciation; whereas the maintenance and depreciation of our line of underground conduit will figure about $120 per annum, figuring one-quarter of one per cent for the maintenance and two per cent for depreciation. I think I have figured high enough in both cases. The difference between these charges is $122 in favor of the underground conduit, while the difference between the maintenance and depreciation of the ærial cables and the underground cables must be all of five per cent per annum on the value of the cables alone. I question if the average would be as low as that.

In the matter of cables let us suppose that we have two 200-pair cables installed, as that is about as heavy a cable as we would care to put in the air. An outside figure on the cost of these cables would be $6,000, while the same cable installed underground would cost somewhat less. Depreciation of five per cent on the ærial cable in excess of that on the underground would be $300. So that we may take for our ærial construction $242 plus $300 equals $542, and for the underground $120 plus $186, six per cent on the excess in cost of underground over ærial, equaling $306, leaving $236 in favor of the underground. It would seem as though it would pay to borrow the $3,100 extra to install the underground if one could make a net profit on it of seven and one-half per cent, not to mention the difference in the cost of maintaining the two classes of cable. Besides all this, in the four ducts underground we have space for 1,800 pairs or more, while our poles would not safely carry more than half that load.

These figures are, of course, subject to modification according to prices of labor and material, but the proportions will hold good. No pavement work is included.

Suppose that we have no use for more than one cable on this line at the present time, the extra messenger would be an additional burden and the cost of maintenance and the depreciation on the line would be less than I figured. If, however, this is a case where we must eventually expect to install two or three or more cables, and that within five years, the same calculations must be made. We can not be too sure when we erect a pole line that we are going to need only a limited amount of wires thereon, and if we can predict a growth at all commensurate with the cost of a line of forty-five or fifty-foot poles, then underground conduit is by far the most economical proposition.

Word to You, Mr. McAdoo.

Enjoy your brief hour of approbation. By the time you have been dealt with by "Anybody's Magazine," and the "Daily Onslaught," and the "Why-Did-You-Do-It Commission," and the attorneys-general of New York and New Jersey, and the Hoboken Strap-Hangers' League, you will wish that your name had been McAdon't.—*Wall Street Journal.*

A Successful Automobile Show in Newark, N. J.

Newark's initial automobile show, February 21-29, was a success not only from the standpoint of the spectator, but from the exhibitor's as well. Many interesting exhibits were made of various makes of cars, among which may be mentioned:

Allen-Kingston Motor Car Company, Allen-Kingston car; Brush-McLaren Motor Company, Brush car; Calvert-Zusi, Jewell car; Calvert-Zusi, Winton car; Sheldon W. Case, Holsman car; Charles S. Cooper, Atlas car; Ellis Motor Car Company, Pierce, Great Arrow and Knox cars; Essex Auto Company, Ford-Jackson car; Garford Motor Car Company, Garford car; Greene Motor Car Company, Locomobile, Oldsmobile, Pope-Waverly cars; Hygrade Motor Car Company, Ford car; P. H. Johnston & Company, Groub and Cameron cars; H. J. Koehler S. G. Company, Buick and Waltham cars; W. S. Maltby, Corbin car; J. W. Mason, Maxwell & Stoddard and Dayton cars; Mitchell Automobile Company of New Jersey, Mitchell car; Motor Car Company of New Jersey, Packard, Autocar, Cadillac and Morton cars; Osborn & Morton, Auburn car; Carl H. Page & Company, Peerless car; Rickey Machine Company, Marman car; A. G. Spalding & Brothers, Stevens-Duryea car; Star Motor Car Company, Pullman-Napier car; the White Company, White car.

Among the interesting accessory exhibits were the following: Electric Motor & Equipment Company, Newark, N. J., fine exhibition of "Exide" batteries, tantalum lamps (with reflectors), dry batteries, flashers, auto oils, "Treco" electric whistle, "Apple" igniter, "Wusol" dusters; the exhibit was in charge of C. R. Hull. H. F. Alexander & Company, New York city; American Auto Rim Company, New York city; Auto Tire Repair Company, Newark, N. J.; Brick Church Auto and Supply Company, East Orange, N. J.; Century Optical Company, New York city; Electrical Maintenance and Repair Company, Newark, N. J.; Ellis Motor Car Company, Newark, N. J.; George A. Haws, New York city; Adolph Karl & Company, Newark, N. J.; C. S. Knowles, Lovell-McConnell Manufacturing Company, Newark, N. J.; National Oil and Supply Company, Harrison, N. J.; Newark Garage and Repair Company, Newark, N. J.; Newmastic Tire Company, New York city; New York Auto Top and Supply Company, Newark, N. J.; Oriental Rubber Company, Newark, N. J.; W. S. Sheppard, Newark, N. J.; C. F. Splitdorf, New York city; Standard Oil Company, Newark, N. J.; The Tea Tray Company, Newark, N. J.; O. W. Young, Newark, N. J.; L. J. Wurth, Newark, N. J.

An English Direct-Current Steam-Turbine Unit.

A somewhat detailed description is given here of a direct-current steam-turbine-driven generating set manufactured by the Brush Electrical Engineering Company, Limited, of Loughborough, England. The first part of the description deals with the steam turbine and describes this somewhat minutely. It is a turbine of the Parsons type. The generator design is interesting, since it is difficult to construct direct-current machines for steam-turbine speeds in large sizes, owing to the severe strains thrown upon the commutator; therefore, in developing these machines, small sizes were first constructed by the company, and the work progressed gradually until now generators rated at 850 kilowatts are built to operate satisfactorily. One machine of this rating was delivered to the Adelaide Electric Lighting and Traction Company early last year, and it has been operating since then without trouble. It runs cool and commutates sparklessly at all loads with fixed brushes. This machine is of the four-pole, shunt-wound type with series interpoles and a compensating winding. The armature is built up of laminations with paper insulation between, and a number of ventilating ducts are provided so that the free circulation of air may take place through the body of the armature to cool the core and winding. As far as possible, every part of the armature is machined over, the details being designed with this object in view, and every part is balanced statically by itself before being erected in position. During the process of building up, the armature is continually checked for balance, and in many cases no balancing at all is found to be required when it is completed and run up to speed. This even distribution of weight during the construction is an important factor, as the addition of balance weights to a completed armature can only be made in certain places, which, as a rule, will not be in the same plane as the out-of-balance mass and, therefore, will not give correct running balance. The former-wound coils, insulated with micanite and leatheroid, are placed in the armature slots and keyed by hard-wood wedges. The ends of the windings are held by manganese-bronze caps. The insulation of the winding is important at high speeds, and as it is not advisable to increase the thickness of the insulation, the strongest and best material should be used and the coils held so that shifting will not be possible. Another possible cause of breakdown is due to the large quantity of air forced through the machine which may carry in copper and carbon dust. In these machines this trouble is obviated in the construction of the machines by hermetically sealing all naked copper bars and connectors. Some possible cooling effect is foregone in this way, but is compensated for by a liberal use of metal. In building up the commutator the thickness of the mica is not greater than that ordinarily used, but the voltage per segment of the commutator is kept low. The segments are held together under high mechanical pressure and are reinforced by steel shrink-rings. The brushes are in pairs, of leaf-copper and Morganite. These brushes are pressed down on the commutator with a pressure of 2.3 pounds to the square inch. No lubrication whatever is used on the commutator. The field yoke is a circular casting of high permeability, split on the horizontal diameter. The pole-pieces are built up of steel plates cast in the yoke; the field coils are former-wound, insulated with micanite and held in position by laminated pole-shoes. The shunt excitation is furnished by a direct-coupled exciter. Slots are punched in the pole-shoe laminations and serve to carry a compensating winding which neutralizes the armature reaction. The commutating field proper is furnished by the series interpoles. With these precautions no trouble from flashing-over of the commutator has been experienced. The estimated efficiency of the machine at full load is ninety-five per cent; at half load, 91.5 per cent. The regulation with constant speed and excitation is seven per cent, and with no alteration made on the governor or exciter, 12.5 per cent.—*Engineering (London), February* 14.

Atmospheric Fog and Electricity.

Attention is drawn here by Charles Chree to a recent remarkable example of an atmospheric electricity phenomenon which usually accompanies London fogs and which may have some bearing on the subject of fog dispersion or prevention. The method employed at Kew Observatory for determining the absolute value of the potential gradient of the atmosphere does not err in the direction of overestimating it. Taking seven years, from 1898 to 1904, the author finds that the mean value of the potential gradient at Kew was 159 volts per metre. The mean value for January was 201. The phenomenon referred to is the occurrence during fog of specially high positive potentials, values double or treble that appropriate to the season not being unusual. At such times, however, there are usually large and frequent oscillations in the value of the gradient, so that the maintenance of an especially high value for a number of consecutive hours is comparatively rare. On the morning of January 21, during an intensely thick fog, the potential gradient at Kew exceeded 730 continuously from 1 to 9 A. M. How much it may have exceeded this value it is impossible to say, as the record passed beyond the limits of the paper; but as the oscillations before and after leaving the sheet were large, the maximum value was probably 1,000. A question of practical interest is whether the steepness of the potential gradient near the ground during fogs serves, or may be made to serve, a useful purpose in helping to clear the atmosphere of dust and smoke. It would also be interesting to know whether these high potentials are wholly without physiological effects on the human body.—*Nature (London), February* 13.

The London Underground.

Reports of the three new tubes, subsidiaries of the Underground Electric Railways of London, England, for six months ended December 31 last, have been received. The figures for the last half of 1907 show that while the Great Northern, Piccadilly and Brompton's gross receipts for the first six months of 1907 were $517,930, for the second half they increased to $579,657. The number of passengers carried for the half year ended December was 13,914,779, as compared with 11,953,759 for the half year ended June. During the first four weeks of the present half year the receipts showed an expansion of fifty-five and one-half per cent over the corresponding weeks of 1907.

In the case of the Baker Street and Waterloo Company, which carried during the half year ended December, 1907, 10,662,876 passengers, as compared with 6,794,895 during the corresponding period of 1906, the gross receipts show a gain of $120,991, or more than fifty-six per cent over the corresponding period of 1906. The third tube, the Charing Cross, Euston and Hampstead, was opened on June 22, 1907, and from that time to December 31 carried 9,881,357 passengers, with gross receipts of $361,234.

The companies controlled by the Underground Electric Railways Company of London, Limited, the three tubes, the Metropolitan District Railway and the London United Tramways Company, carried during the second half of 1907 almost 100,000,000 passengers.

ARTIFICIAL DIAMONDS.

BY JOHN B. C. KERSHAW.

The arrest and trial of a French engineer and metallurgist, named Lemoine, for fraud in connection with a process for the production of artificial diamonds, revives interest in the previous attempts which have been made to solve this most interesting and fascinating problem.

It is probably not known to the majority of people that diamonds of small size have been made artificially by at least four of the scientists, who have devoted time and money to this subject. Had Sir Julius Werner been aware of these successful attempts when negotiating with M. Lemoine for the purchase of his process, he would doubtless have been more chary in parting with his thousands.

Even should M. Lemoine have succeeded in making larger diamonds than the other experimenters, a fact which is by no means proved, the question of patent validity and of anticipation is certain to arise when the attempt is made to exploit the latest process upon a manufacturing basis.

The processes by which diamonds have been made artificially are, with one exception, alike in principle, and there is no reason to suppose that the secret process of M. Lemoine differs in essential details from its predecessors.

Many of the elements are able to unite with carbon at a very high temperature, to form compounds called "carbides." The advent of the electric furnace has led to the production of a large number of carbides, two of which are of industrial value, namely, calcium carbide and silicon carbide or carborundum.

When certain of these carbides (iron carbide is most generally employed) are cooled under great pressure, the combined carbon separates from the compound in the crystalline form, and diamonds are produced.

The famous French chemist, Henri Moissan, who died last year, was the first chemist to make diamonds in the laboratory by this method. Moissan took for his experiments one-half pound of pure iron and packed this with carbon made from sugar, in a carbon crucible. The crucible was heated by an electric arc, representing 100 horse-power for a few minutes, a temperature of 4,000 degrees centigrade being attained. The crucible was then plunged into cold water or into molten lead. The rapid cooling of the containing vessel and of the outer crust of iron caused enormous pressure to be exerted upon that portion of the mass which was the last to assume the solid form, and on breaking up this mass of metal and treating the same with chemicals, minute crystals of carbon, or true diamonds, one millimetre in diameter, were found. Moissan's attempts to produce larger crystals by this method failed.

Marjorana, an Italian chemist, modified Moissan's experiment by using carbon alone. By subjecting this carbon to enormous pressure while at a white heat, in an ingenious modification of the ordinary electric arc furnace, minute diamonds were again formed. This experiment proved that the combined effects of high temperature and great pressure with rapid cooling would suffice to convert amorphous carbon into the crystalline variety; but nothing practical resulted from this variation of Moissan's original method.

H. W. Fisher, chief engineer of one of the New York underground cable companies, has also carried out experiments upon the production of artificial diamonds, using Moissan's method, with a device for more quickly dropping the carbon crucible into the cooling water. Crystalline carbon was again obtained, but the diamonds were too small to be of commercial value.

Sir William Crookes in a lecture delivered at Kimberly during the South African meeting of the British Association (1905) gave details of his own experiments relating to this subject. In this case, cordite was exploded in closed vessels containing pure carbon; a temperature of 5,000 degrees centigrade and a pressure of fifty tons per square inch being obtained. Minute diamonds were again produced.

The experiments of Dr. A. Ludwig and of other workers in this field of research have also resulted in the production of a new variety of carbon—possessing some of the properties of the diamond, though lacking its hardness and brilliancy.

The fact that although these scientific workers have devoted great ability and much time to the subject of their investigations, they have only succeeded in makng diamonds of microscopic size is proof of the difficulty of the problem, and raises great doubts as to the worth of M. Lemoine's secret process for making diamonds of commercial value.

The following extract from the lecture delivered by Sir William Crookes at Kimberly might well be studied by Sir Julius Werner and other financiers before parting with more of their money to those who claim to have solved the mystery of diamond manufacture:

"From the earliest times the diamond had fascinated mankind. It had been a perennial puzzle—one of the 'riddles of the painful earth.' The five mines at Kimberly are all contained in a circle three and one-half miles in diameter. Before the discovery of the deposits there was nothing in the superficial appearance of the ground to indicate the treasure below. Since the filling of the volcanic ducts with diamondiferous ground, denudation had planed the surface and the upper parts of the craters, and other ordinary signs of volcanic activity being smoothed away, the superficial and ubiquitous red sand had covered and disguised the whole surface. Other diamondiferous pipes in the neighborhood were small, and did not contain stones in payable quantities.

"How the great diamond pipes were originally formed was hard to say. They were certainly not burst through in the ordinary manner of volcanic eruption, since the surrounding and enclosing walls showed no signs of igneous action, and were not scattered and broken up even when touching the 'blue ground.' It was fairly certain that these pipes were filled from below after they were pierced, and the diamonds formed at some previous time and mixed with a mud volcano, together with all kinds of debris eroded from the rocks through which it erupted, forming a geological 'plum pudding.' It might be that each volcanic pipe was the vent of its own special laboratory—a laboratory buried at vastly greater depths than had yet been reached—where the temperature was comparable with that of the electric furnace, where the pressure was fiercer than in our puny laboratories and the melting point higher, where no oxygen was present, and where masses of liquid carbon had taken centuries, perhaps thousands of years, to cool to the solidifying point. The chemist arduously manufactured infinitesimal diamonds, valueless as ornamental gems, but nature, with unlimited temperature, inconceivable pressure and gigantic material, to say nothing of measureless time and appalling energy, produced without stint the dazzling, radiant, beautiful, coveted crystals now before the audience."

Westinghouse Electric and Manufacturing Company.

The committee for the readjustment of the debt of the Westinghouse Electric and Manufacturing Company has given notice that it has extended the period of limitation for the deposit of obligations and claims to March 31.

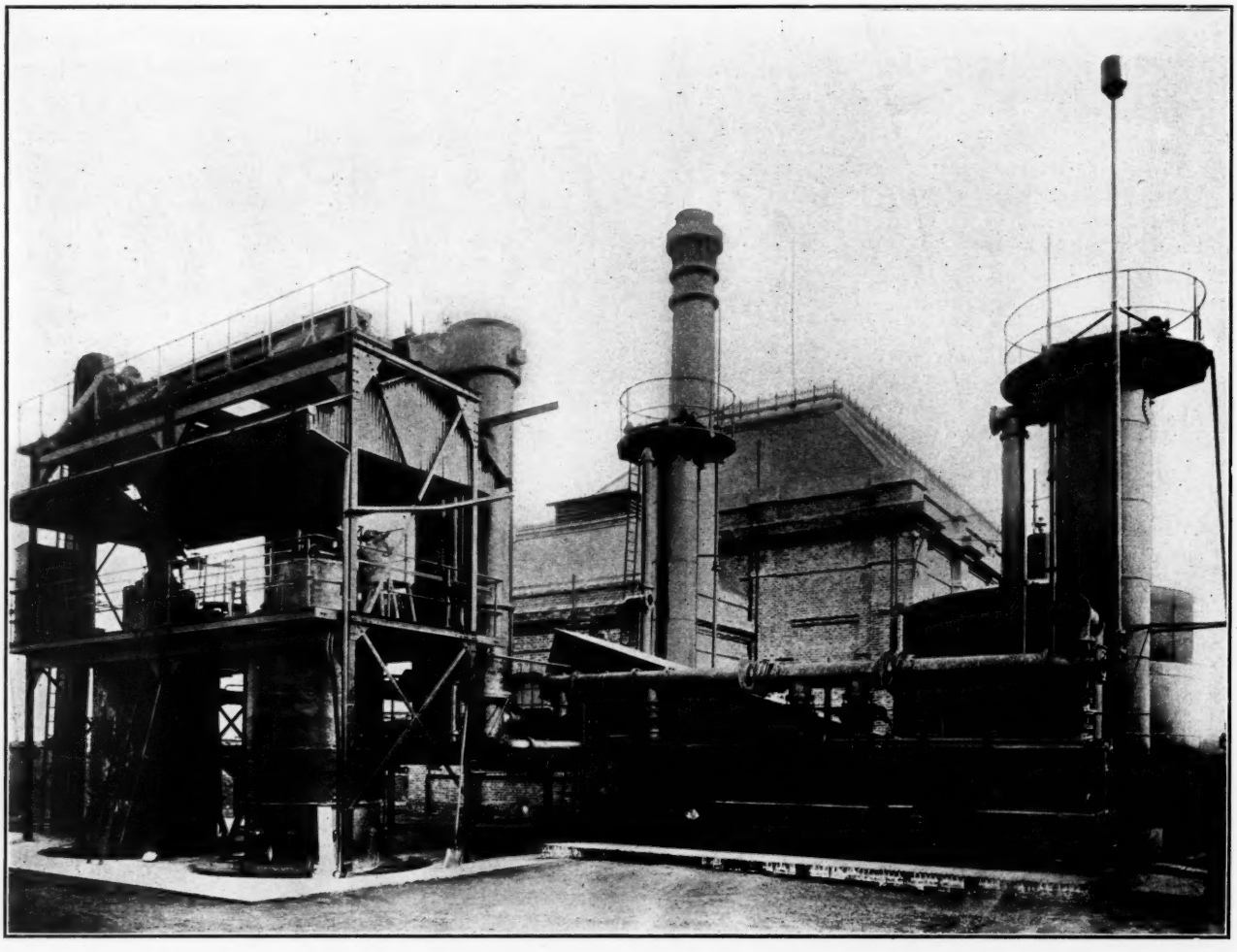
A meeting of the Westinghouse Electric and Manufacturing Company stockholders has been called for April 29 to consider the bond and stock issues as suggested in the plans of the creditors' committees.

South American Producer Power Plants.

SEVERAL years ago there were established at Buenos Ayres, Argentine Republic, two high-grade producer-gas power plants using imported bituminous slack coal, and each serving an extensive aggregation of passenger, freight and car-shop buildings for the terminals of the Great Western and the Great Southern railways respectively. The larger of these, at Banfield, serves the former; the smaller, at Liniers, the latter. Both plants are equipped with Westinghouse gas-engine-driven alternators for electric distribution, and Mond bituminous producers without by-product recovery. Part of the engines were furnished by the Westinghouse Machine Company, at East Pittsburg, and part by the British Westinghouse Electric and Manufacturing Company, Limited.

The service from the two plants is quite similar, and as the equipments are almost identical, a general description of the system will suffice for present purposes. The accompanying illustrations are typical, and are of much interest, particularly from the fact that these two plants are the first gas-power installations in South America. Both have been highly successful and offset to a considerable extent the discouraging reports from Johannesburg.

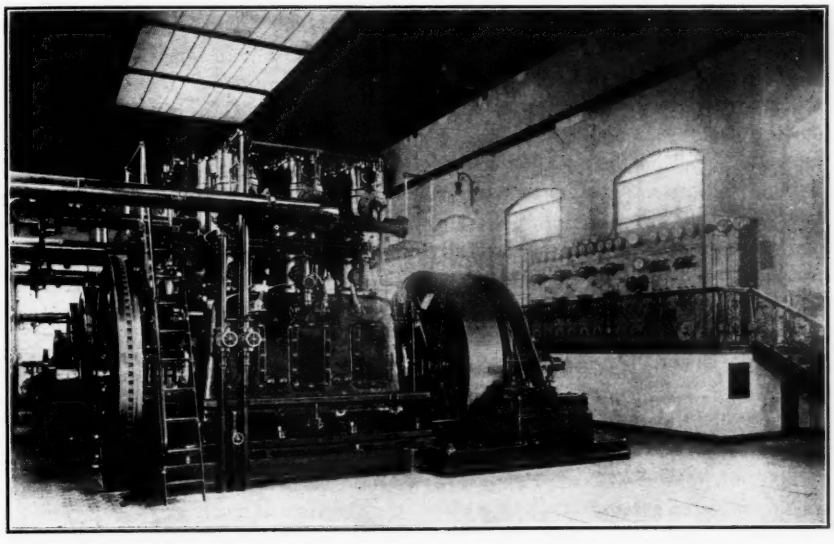
These two installations aggregate 2,375 brake-horse-power — 1,500 brake-horse-power at Banfield in six units and 875 brake-horse-power at Liniers in four units. Most of the engines are of the nineteen-inch by twenty-two-inch, three-cylinder, vertical type of the No. 1 design, direct-connected to 150-kilowatt standard Westinghouse, three-phase, fifty-cycle alternators, spring-coupled and with continuous bed-plates. All of these engines operate in parallel on shop load. At Banfield electrical distribution is carried out at 6,600 volts through underground conduit to substations and other centres of consumption, while at Liniers the 440-volt, three-phase system was adopted. The shops and terminals are completely electrified with induction-type motors, and individual drive is largely used for such purposes as cranes, capstans, elevators, blowers, pumps, air-compressors, etc. Group driving is employed only in the case of small tools. At the Liniers works there are introduced ninety-three motors, from one-quarter to eighty horse-power, aggregating 1,071.5 electrical-horse-power, practically equal to the generating capacity.



EXTERIOR VIEW OF LINIERS POWER-HOUSE, SHOWING GAS PRODUCERS, REGENERATORS, MECHANICAL TAR EXTRACTOR, WATER AND AIR TOWERS AND GAS-HOLDERS.

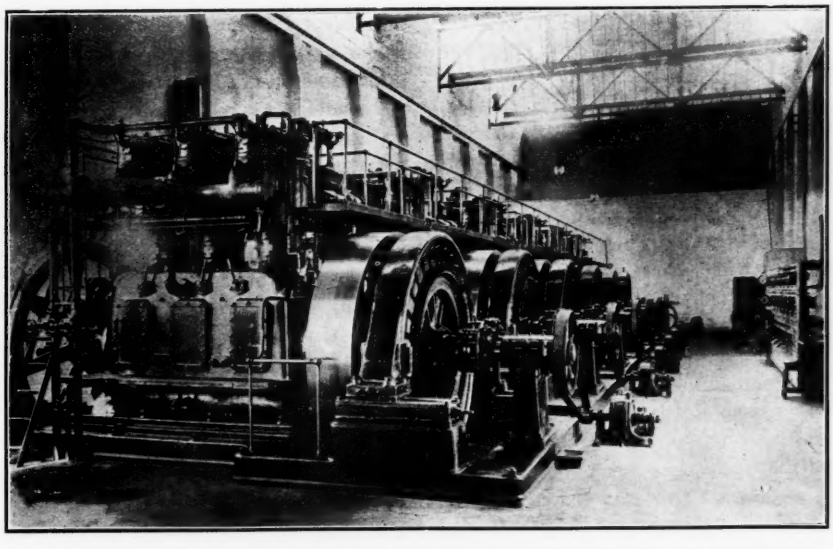
The most interesting feature of the producer plant is that it is operated successfully on bituminous slack coal, averaging 12,250 British thermal units per pound, and costing from $5.60 to $6.70 per net ton delivered. The equipment was manufactured by the Gas Power Corporation, of London, and is the standard Mond system without by-product recovery.

Briefly, the arrangement is as follows: Referring to the Liniers plant: The producers are of the water-sealed type and double-walled with internal fuel-distributing cone extending well down into the producer so as to maintain a constant level. Blast is supplied by a steam-driven Roots blower, and before reaching the producer, passes through a series of economizing operations designed to return the latent heat of the gases to the fuel bed in the form of hot blast. First, the blast is heated and saturated in its ascent through an air-heating tower, which is in turn supplied with hot water from gas-cooling tower. Second, the hot saturated air blast is then conveyed to vertical superheaters stationed at the outlet to each producer and shown at the rear. These are simply double, concentric pipes in which the hot gas descending delivers its sensible heat to the ascending air. Finally, the hot vapor-laden air blast passes down the outer wall, or air jacket, of the producer shell and enters the fuel bed at the bottom through a conical tuyere.



INTERIOR OF LINIERS POWER-HOUSE, SHOWING THREE WESTINGHOUSE GAS ENGINES DIRECT-CONNECTED TO THREE-PHASE MULTIPOLAR GENERATORS OPERATING IN PARALLEL.

Gas is drawn off above the fuel bed, and, after traversing the superheaters, is partly cleansed and cooled in a rotary washer of the splash type. This is shown in a long rectangular box in the foreground, fitted with two rotary splashers. It is further cooled in ascending through a gas-cooling tower filled with earthenware checker brick, wet down with a spray of water from the air-heating tower. This water is thus alternately cooled and heated and simply serves to transfer heat from the gas to the air, thus returning to the fuel fire-bed. Finally the gas is piped to a gas-holder, thence to centrifugal dust and tar extractors, and lastly through sawdust scrubbers. Steam used for operating conveyers, dashers and fans, is carried into the air main and used up in the producer. All steam is supplied from a small locomotive-type boiler in duplicate.



INTERIOR VIEW OF BANFIELD POWER-HOUSE, SHOWING SIX VERTICAL WESTINGHOUSE GAS ENGINES DIRECT-CONNECTED TO THREE-PHASE MULTIPOLAR GENERATORS OPERATING IN PARALLEL.

At Banfield the plant operates normally twenty-four hours per day, giving largely power service during the day and lighting service during the night. The former yields a loading factor of about fifty per cent, but during the night the loading is light—about ten per cent plant capacity. Owing to the occasional abnormal fluctuations in load, an idle engine is usually kept running during one shift, which tends to decrease somewhat the plant economy. Eight-hour shifts are maintained. While the engine-room staff is normal, the gas plant requires considerably more labor than usual owing to the short shifts and poor coal. As a matter of fact, considerably greater producer-plant capacity could be operated by the same staff, including the necessary attention to tar and auxiliaries.

AVERAGE OPERATING COSTS—1,500 HORSE-POWER WESTINGHOUSE-MOND PRODUCER PLANT—BUENOS AYRES GREAT SOUTHERN RAILWAY.

	Day.	Night.	Average.	Per Cent of Total.
Coal: 10,000 British thermal units slack at $5.60 per ton	$0.52	$0.88	$0.76	44.4
Wages: Engine room	.16	.53	.32	18.7
Wages: Producer room.	.32	.45	.38	22.2
Supplies and stores	.10	.20	.13	7.6
Running repairs	.12	....	.12	7.1
Total cost per kw-hour.	$1.22	$2.06	$1.71	....

These costs represent an average over six months' operation for the loading factors above-named. During this period the average consumption of bituminous slack at the plant, including standby and all losses from the ship's hold to the producer, was about three pounds per kilowatt-hour, or for the day load about two pounds per kilowatt-hour. Even at the prevailing high price, the coal is of very poor quality, not much exceeding 10,000 British thermal units per pound. This is partly due to the fact that owing to the number of times the coal has to be handled it becomes powdered to such an extent that screening is impossible on account of the great waste. As the fine coal sometimes runs as high as forty per cent of the total, this increases the difficulty of handling in the producer, also necessitating at the same time more producer labor than would be necessary with a more suitable coal.

Fireproof Power-Houses.

In the current issue of the "Quarterly" of the National Fire Protection Association, C. B. McKinney, of Providence, R. I., lays down some rules and discusses the construction of modern fireproof power-houses. Mr. McKinney says:

"Electric power stations are increasing in number very rapidly in this country and can be most desirable or most undesirable fire risks, and, as a class, vary between wider extremes than the risks in most classifications. Power stations built in the last few years are, with some exceptions, good fire risks, for the reason that fire protective features lend themselves very readily to the design, without in any way interfering with the use to which the plant is to be put. Also, because the great horror to the operating department of a traction or lighting system is a 'shutdown,' the engineers are more apt to follow the advice of fire insurance experts than is the case in some other lines of business.

"Disregarding exposure, a power station can be built that will be perfectly practical from an operating and financial standpoint, and at the same time as safe as the average fireproof office building, and should be subject to no greater or more frequent losses. To do this, however, every item of arrangement, construction and the handling of electrical features should be given the most careful consideration. If proper talent is employed on this, the corporation owning the plant will have a risk which should be practically free from interruptions to service or shutdowns from fire, and it should be a very durable, sightly and an altogether satisfactory station.

"The generator room is usually one high story in height, with sufficient head room to accommodate traveling cranes. The floor of the room is of some type of fireproof construction, with a granolithic surface, which is pierced by numerous holes to accommodate the machinery, stairways and piping connections. To facilitate the erection of the switchboards and their connections, the portion of the floor under them is sometimes made of wood, which is a defect and is not necessary. If the switchboard apparatus is on a gallery, this whole structure should be of fireproof construction, all wood trim and railing being left off. It has been proposed in some cases to divide the generator room into two or more fire sections, but, except in very large stations, this is not necessary and is not favored from an operating standpoint. The under-floor space in this room contains all auxiliary machinery connected with the engines and dynamos, as well as the foundations of these machines. Great care should be exercised that no woodwork or combustible materials are used in this room, and it is advisable to so design the station that this room will be lighted and ventilated by outside windows. Where this is impossible, it is wise to keep all portions of this space brightly lighted at all times, as it promotes cleanliness, and also in case of trouble men can find their way around in it without difficulty. The material which enters into the covering of the cables and piping in this space should be carefully investigated and incombustible material used as far as possible. The pockets for the bolt heads in the machinery foundations should be bricked up and, where possible, the pits in which the generators revolve should be built large enough to admit of easy inspection and cleaning.

"This basement space in stations which deliver underground sometimes have motor switches, lightning arresters, complicated masses of cables and even transformers. In designing a station this use of the room should be avoided if possible, but if it is found necessary to install any of this apparatus in this space it should be cut off by fireproof partitions or walls both vertically and horizontally. The boiler room is ordinarily cut off from the generator room by a heavy brick wall. This wall, of course, is pierced by many openings for piping as well as doorways. It is difficult to protect these openings so as to make this fall a standard cutoff, but in a station like the one now under discussion this is not considered necessary. The boiler rooms differ in the different stations more than do the generator rooms. There is generally a basement which contains the ash-transfer system and some minor machinery. There is then one, two and sometimes three tiers of boilers, each of which is surrounded by a fireproof floor. Above this there is either a room which contains the coal-distributing machinery used in connection with the mechanical-stoker equipment, or, in some cases, a superimposed coal pocket, over which comes a roof similar to that over the generator room. From an insurance standpoint this coal pocket is a hazard, and by many station engineers is not considered desirable from an operating standpoint. However, due to land values or other considerations, this arrangement is sometimes deemed advisable. All of the metal members of the portions of the building used for coal storage should be carefully protected, and where soft coal is used the pocket should be divided into sections holding not more than 500 tons each.

"The oiling system in this class of stations generally consists of a gravity feed from a tank holding about fifty gallons or less, which is in some elevated position in the generator or boiler room. This tank is connected by a system of piping to all the principal bearings about the station, and to several stands where the hand oil-cans are filled. The oil tank is filled by pump from the oil room. If detached this room should be fireproof, well lighted, both naturally and artificially, and heated by steam. If incorporated in the main building it should have access only from out of doors. If this arrangement is found impracticable, and it is made to communicate, the doorway should have a threshold twelve inches high, and should be protected by a standard swinging fire-door, fitting very tightly, and an automatic sliding door. This room should be drained to a blind pit.

"The electrical hazards are generally very well safeguarded in a station of this sort. All wire, fittings and apparatus should be of approved types, and the 'National Code' should be strictly adhered to in this installation. Cables should be installed on non-combustible supports, and grouping of cables should be avoided as much as possible. It is important that all wiring, with the exception of the heavy cables, should be installed in conduits. It is advisable also to have the cables either in conduits or in ducts built into the walls and floors of the station. This latter arrangement sometimes meets with objections from station engineers, but there is no record of trouble having occurred where this plan has been carried out.

"The wire tower of the old-time station seldom, if ever, occurs in the modern plant, the main cables being led directly from the basement into underground conduits. It is often found necessary to partition off the portion of the basement where the cables leave the plant, on account of the illuminating gas that finds its way into the building through the open ends of the conduits. This room or space should be well ventilated and lighted by lamps in keyless sockets with controling switches outside. High-tension circuit-breakers and large oil switches should be installed in compartments by themselves. The station is, of course, lighted by electricity, sometimes the current being taken from some other source, so that in case of trouble to its own apparatus its lighting will not be interfered with."

STANDARD PERFORMANCES OF ELECTRICAL MACHINERY.[1]

BY DR. RUDOLPH GOLDSCHMIDT.

All electric motors and dynamos work through the interaction of the magnetic flux and the ampere-turns. Whatever machine one may select, whether it be an induction motor, an alternator, a synchronous motor, or a direct-current machine, one always finds a cylinder carrying ampere-turns on its circumference and a magnetic flux entering this cylinder in a radial direction. The torque is the product of both; or, taking

$$\text{Torque} = \text{const.} \times \frac{\text{KW}}{\text{Revs.}}$$

and calling "power" the kilowatts reduced to 1,000 revolutions per minute, then

"Power" = KW at 1,000 revs. = const. × ampere-wires × flux = const. × AW × F.

With direct-current machines, polyphase alternators, and polyphase induction motors, the constant averages 0.165×10^{-9}; with single-phase machines it averages 0.145×10^{-9}.

By "ampere-wires" is understood the total number of conductors which are cut by a plane in the middle of the armature at right angles to the shaft, multiplied by the number of amperes per conductor.

With induction motors the ampere-wires are those of the rotor only. The flux is the sum of all fluxes entering the armature from all poles together.

It is naturally possible to obtain a certain "power" with an infinite number of combinations of ampere-wires and fluxes. In actual practice the figure for both will be of the same order if we express AW in 10^3 (kiloamperes) as unit, F in 10^6 megalines; (1 megaline = 167 kapplines).

The conditions fixing AW and F vary for every class of machine, and are not always those of economy of design. With direct-current machines the commutation, with alternating motors the pull-out, with alternators the voltage drop, come into consideration. Of the two factors, AW and F, working together to produce the output, one, F, is constant, while AW increases with the load. AW tends to destroy F, and causes sparking or voltage drop. Therefore, in order to produce a good machine F must not be too weak. It is due to these well-known conditions that F and AW do not actually vary so very much. The effect on the efficiency, which is the chief item about to be considered, is very small indeed, even if F varies by quite a considerable amount, as will presently be seen.

There are certain sections required for F and AW, as the density must not exceed a certain figure, limited by heating or saturation (teeth). Further, the length of path which the flux and AW have to flow in is also very nearly fixed, as both are interlinked, and have to surround one another. Therefore, if the AW and the size are given, the copper losses due to AW are pretty well fixed, as well as the core loss, provided the speed at which the flux revolves is known. Figures in detail on this point for direct-current machines are given below.

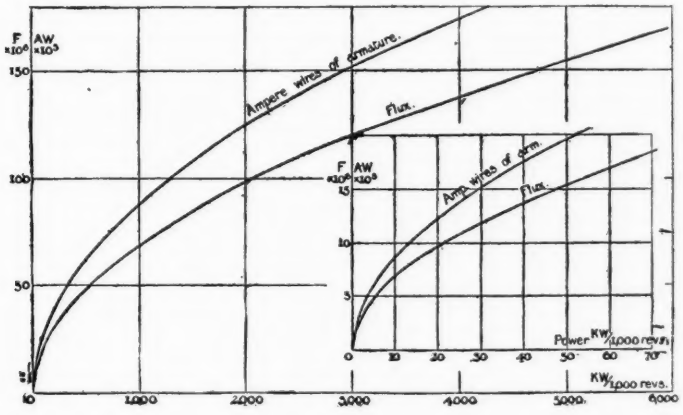


FIG. 1.—DIRECT CURRENT. STANDARD FLUXES AND AMPERE WIRES OF ARMATURE.

DIRECT-CURRENT MACHINES.

Fig. 1 shows F and AW for different KW at 1,000 revolutions, and the figures may be considered normal for machines having no commutating poles. In most cases these fluxes are identical with the most economical flux, especially with moderate speeds. With commutating poles the flux may be twenty-five per cent or even thirty-five per cent less. There is also some variation, dependent on whether the machine is very narrow or excessively broad, on the number of poles, etc. We will disregard this for the present.

The core loss caused by a certain flux, F, is proportional to the speed. Taking 1,000 revolutions per minute as the unit of speed, Fig. 2 shows the core loss at different fluxes. If it is desired to know what the core loss of a 500-kilowatt ma-

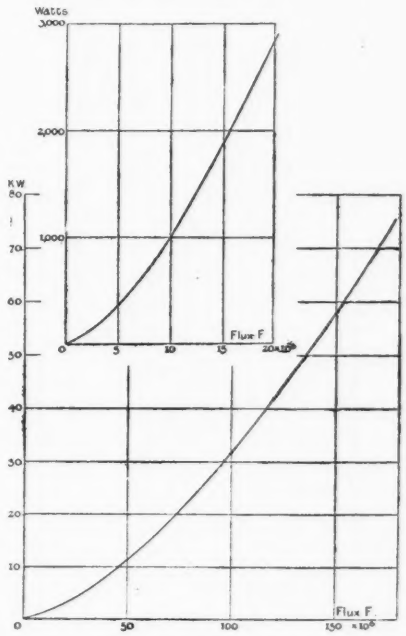


FIG. 2.—DIRECT CURRENT. CORE LOSS AT 1,000 REVOLUTIONS PER MINUTE WITH DIFFERENT FLUXES.

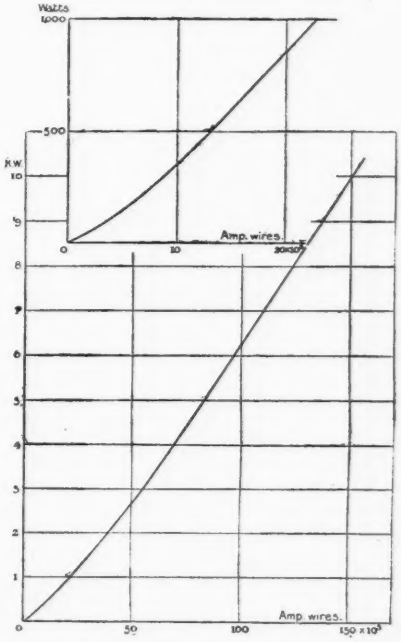


FIG. 3.—DIRECT CURRENT. COPPER LOSS OF ARMATURE WITH DIFFERENT AMPERE WIRES.

[1] A paper read before the Institution of Electrical Engineers of Great Britain, January 23.

chine is likely to be, the speed being 250 revolutions per minute, we take "power" $= 500 \times \frac{1,000}{250} = 2,000$ kilowatts at 1,000 revolutions, and take from Fig. 1 flux F = 99 megalines; Fig. 2 shows that the core loss $p_{fe} = 31,000$ watts with F = 99 at 1,000 revolutions; that is, at 250 revolutions. $\frac{250}{1,000} \times 31,000 = 7,750$ watts, or $\frac{7,750}{500,000} = 1.55$ per cent. It must be understood that, if $p_{fe} = \text{const.} \times \text{revs.}$, this is not correct for one and the same machine. There are eddy-current losses, which increase as the square of the speed. the hysteresis only being proportional to it. But in our case the machine with more flux is a different machine, more iron section being provided. This is the reason why we are entitled to make the core loss practically proportional to the speed.

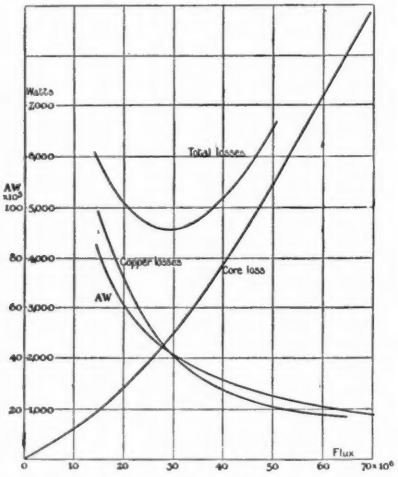


FIG. 4.—DIRECT-CURRENT GENERATOR. 100-KILOWATT, 600 REVOLUTIONS PER MINUTE, LOSS IN ARMATURE WITH DIFFERENT FLUXES AND AMPERE WIRES.

The armature copper loss is dependent on AW only, as shown by Fig. 3. In the case of our example we take from Fig. 1 for 2,000 kilowatts at 1,000, AW = 125 kiloamperes, and from Fig. 3, 8,100 watts copper loss, $p_{cu} = \frac{8,100}{500,000} = 1.62$ per cent.

Copper and iron loss together amount to 1.62 + 1.55 = 3.17 per cent.

Picking out the same figures for a 100-kilowatt machine, running at 500 revolutions, we find, from Fig. 1, F = 31, AW = 40, and from Figs. 2 and 3

Core loss = 2,650 watts;
Copper loss = 2,000 watts;
Total, 4,650 watts = 4.65 per cent.

If F were reduced by twenty per cent, or to twenty-five megalines, AW would rise to fifty kiloamperes, and

Core loss = 1,950 watts;
Copper loss = 2,650 watts;
Total, 4,600 watts = 4.6 per cent.

The total losses, therefore, have not changed. In Fig. 4 the AW, copper, core, and total losses have been drawn up for 100-kilowatt, 500-revolution machines, designed with different fluxes, and it will be noticed that the total losses are practically unchanged (that is, only between 4,550 and 5,000 watts) if the flux is altered from twenty-one to thirty-seven megalines. The losses with well-designed machines can not be far from this minimum, as it is very expensive to provide surface for extra losses.

For convenience sake I have combined Figs. 1, 2, 3 to form Fig. 5, where the losses are expressed in percentages of the output, and as a function of the "power" KW at 1,000 revolutions. By expressing them as a percentage, p_{fe} is now independent of the speed, while p_{cu} is inversely proportional to it. As unit of speed we take again 1,000 revolutions per minute.

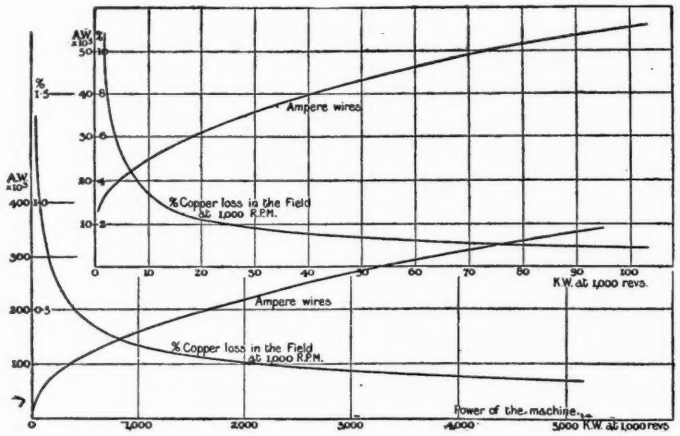


FIG. 6.—DIRECT CURRENT. FIELD COPPER LOSS IN PERCENTAGE OF OUTPUT.

For a 100-kilowatt machine at 500 revolutions: Power P = 200, core loss 2.65 per cent, copper loss $1 \times \frac{1,000}{500} = 2$ per per cent of 100 kilowatts.

The ampere-turns of the field magnets are a function of armature ampere-turns and flux, the former demagnetizing and the latter requiring to be driven through the air-gap. These ampere-turns have to surround the flux coming from the armature, which fixes their mean path, so that there exists a law which connects the power of a machine with the losses in the field.

I will define the expression "field am-

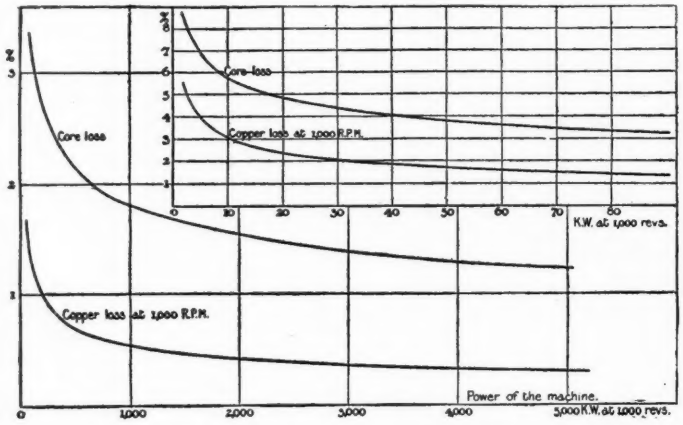


FIG. 5.—DIRECT CURRENT. CONNECTION AND COPPER LOSSES IN PERCENTAGE OF OUTPUT.

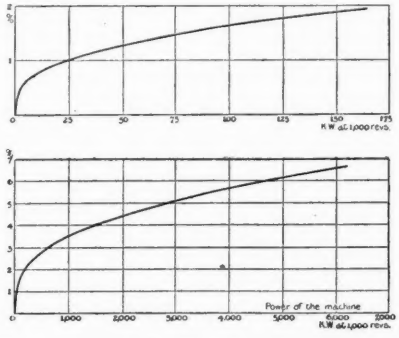


FIG. 7.—BRUSH FRICTION LOSS AT 1,000 REVOLUTIONS AND 200 VOLTS.

pere-wires" as the field ampere-turns per pole multiplied by the number of poles and multiplied by two.

The field AW and the losses as a function of the power are shown in Fig. 6. The losses are again expressed in percentages of the output, and, for correction, require to be varied in inverse ratio to the speed, 1,000 revolutions per minute

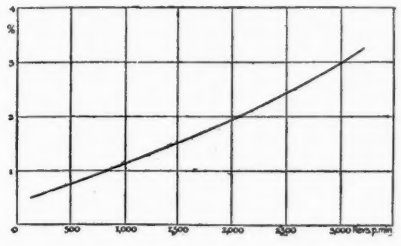


FIG. 8.—BEARING FRICTION AND WINDAGE.

being again taken as normal. It may be noted that with large machines the field AW is about twenty-five per cent more than the armature AW, and that 1,000 AW is about the lowest figure found with very small bipolar machines. A 100-

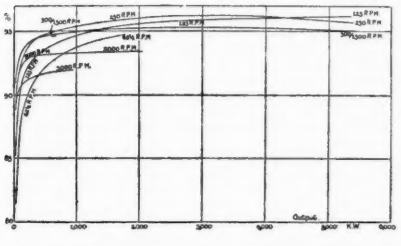


FIG. 9.—EFFICIENCIES OF DIRECT-CURRENT MACHINES, 500 VOLTS.

kilowatt machine, running at 500 revolutions per minute, would have (Fig. 6)

$$0.67 \times \frac{1{,}000}{500} = 1.33 \text{ per cent losses in}$$

the field magnets. In machines with commutating poles the losses in the main poles are reduced, but this reduction is made up for by the losses in the commutating poles.

It remains to consider the friction losses.

The most difficult question is that of the brush friction, but here also there exists a definite relation between current, current density in the brushes, and voltage drop, coefficient of friction, and friction losses. Also the commutator diameter can be approximately determined from the output; so that, choosing 200 volts and 1,000 revolutions as normal, a curve can be plotted (Fig. 7) giving the percentage brush-friction as a function of kilowatts at 1,000. These figures vary inversely as the voltage and directly as the speed.

Example: 100 kilowatts, 500 revolutions, 500-volt dynamo. Power, 200 kilowatts at 1,000. From Fig. 7: 2.1 per

$$\text{cent} \times \frac{500}{1{,}000} \times \frac{200}{500} = 1.7 \text{ per cent.}$$

The bearing friction and windage are practically independent of the "power," and depend almost solely on the angular velocity—that is the revolutions per minute. Fig. 8 gives practical average figures for this class of friction.

The voltage drop in the brushes expressed as a percentage may be taken as $\frac{200}{\text{volts}}$. It is somewhat less with high-current and somewhat more with high-voltage machines. With copper brushes it may drop to about $\frac{100}{\text{volts}}$, but ought not to be assumed to be lower. For instance, a 500-volt machine would have a loss of $\frac{200}{500} = 0.4$ per cent, due to voltage drop in the brush contact.

The Figs. 5, 6, 7, 8 enable the efficiency of any direct-current machine to be estimated. Referring again to the example of

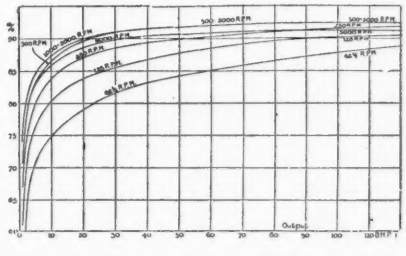


FIG. 10.—EFFICIENCIES OF DIRECT-CURRENT MACHINES, 500 VOLTS.

a 500-volt, 100-kilowatt, 500-revolution machine, we find:

Core loss	2.65	per cent.
Arm. copper loss	2.0	"
Field " "	1.35	"
Brush friction	0.45	"
Windage and bearing friction	0.75	"
Brush drop	0.40	"
Total	7.60	" of output.
Output	100.0	"
Input	107.60	"
Efficiency	92.9	"

To avoid going into details, the total efficiency has been plotted in Figs. 9 and 10 for different speeds and as a function of the actual output (not "power" in this case) of the machine, Fig. 9 giving the efficiencies of dynamos up to 5,000 kilowatts. In Fig. 10 the abscissæ represent brake horse-power, but naturally motor and dynamo efficiencies are practically identical, so that Fig. 10 can also be used for dynamos. The voltage has been assumed to be 500 volts. If the voltage is different, a correction may be carried out in the brush friction and brush drop. The comparatively low efficiencies at very high speeds are due chiefly to friction and core loss.

Figs. 9 and 10 give only the full-load efficiency. An idea of the performance with smaller loads can be gained by referring to the curves giving the losses in detail.

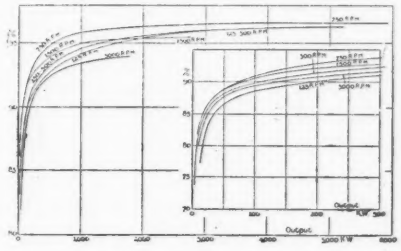


FIG. 11.—TWO AND THREE-PHASE ALTERNATOR EFFICIENCIES, FIFTY CYCLES.

ROTARY CONVERTERS.

The efficiency of a rotary converter may be obtained from the efficiency of the corresponding direct-current machine, making allowance for the losses on the

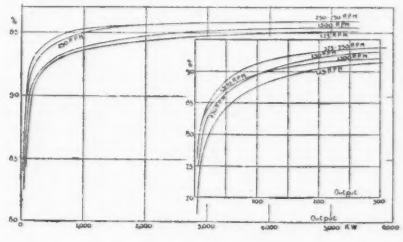


FIG. 12.—TWO AND THREE-PHASE ALTERNATOR EFFICIENCIES, TWENTY-FIVE CYCLES.

alternating-current slip rings. For this purpose the curves in Fig. 7 may be used, reducing the friction found in this way to about one-half. This is naturally only very approximate. The output of a direct-current machine can be increased by a certain percentage, if used as a rotary, with three-phase current by thirty-three per cent, and with six-phase by ninety per cent. As the power-factor is not always unity, and a slight deviation from this reduces the output again, it can not be assumed that the latter is increased by the full amount, but only, say, by twenty and forty per cent respectively. For approximate estimates the following formulæ may be used:

$$g_r = \frac{g}{0.93 + 0.07 \times g} \text{ for 3-phase, and } g_r = \frac{g}{0.81 + 0.19 \times g} \text{ for 6-phase,}$$

where g_r is the rotary efficiency and g the efficiency of a direct-current machine which is

$\left(\frac{1}{1.20} - 1\right) = 17$ per cent and 28 per cent smaller; g is to be taken from Figs. 9 and 10. Thus a 500-kilowatt direct-current machine at 250 revolutions would as a three-phase rotary have an efficiency of

$$\frac{94.7}{0.93 + 0.07 \times 0.947} = 95 \text{ per cent.}$$

ALTERNATORS.

The task of developing standard efficiencies for alternators is a very difficult one, as the law fixing the size of the machine is very complicated if the number of poles and the diameter are small. We can speak of the "output" of the field

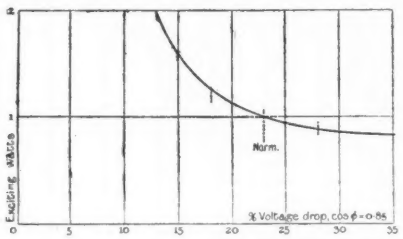


FIG. 13.—VOLTAGE DROP OF ALTERNATORS.

and the "output" of the armature separately. Our output formula kilowatt at 1,000 = 0.165 × AW × F refers to the armature only. Now, if we wish to make a good machine with not too much voltage drop, the AW of the field must be a multiple of the AW of the armature, say, three or four times as much. The flux in the field exceeds that in the armature by the amount of the leakage flux. Consequently the "output" of the field must be considerably more than that of the armature. As the field in the case of modern alternators is generally inside the

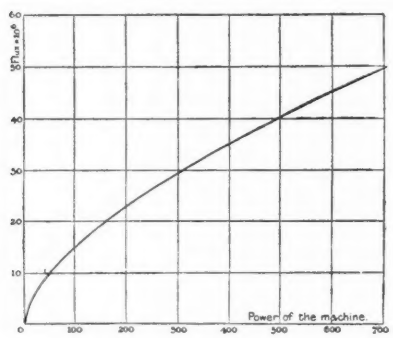


FIG. 14.—INDUCTION MOTORS. FLUXES. HORSE-POWER AT 1,000 REVOLUTIONS.

armature, its mean diameter is smaller than that of the latter. Consequently it is often a difficult matter to provide room for sufficient AW and F, and the output of the whole machine has to be reduced. I should say that with machines below five to six feet in diameter and a moderate number of poles this difficulty is always experienced. In such cases the output of a certain size of machine may be considerably increased by the admission of a higher voltage drop or by compounding.

On account of these difficulties I decided not to reproduce here the curves for the detail losses of alternators, as they would have been too numerous, but to give the results only.

Figs. 11 and 12 show the efficiencies of medium-volt polyphase alternators for fifty and twenty-five cycles, respectively, the power-factor being unity.

The falling off of the efficiency with very high speeds due to the friction and core loss will also be noticed here. In comparing alternating-current with direct-current machines, large alternators are

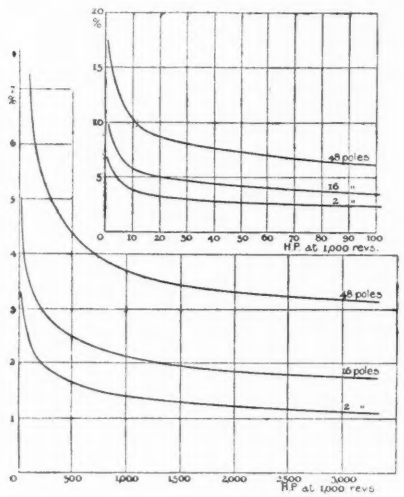


FIG. 15.—CORE LOSS OF INDUCTION MOTORS.

found to be slightly more efficient than large direct-current machines, on account of the commutator losses of the latter, but the reverse is the case with small machines where only small currents have to be dealt with on the commutators and where the alternators require considerable excitation.

To find the efficiency of single-phase alternators it must be remembered that the output of a certain machine as a polyphase alternator is about fifty per cent more than as a single-phase one. The losses of the latter may therefore be taken as those of a fifty per cent larger polyphase machine. If we wish to know the efficiency of a fifty-cycle, 1,000-kilowatt alternator, running at 250 revolutions, we pick out from Fig. 11 the efficiency for 1.5 × 1,000 = 1,500 kilowatts, polyphase, 250 revs. = 95 per cent. The losses are $\frac{1}{0.95} - 1 = 5.2$ per cent of 1,500 kilowatts = 1.5 × 5.2 = 7.8 per cent of 1,000 kilowatts. Therefore, as 1,000-kilowatt single-phase alternator the machine has $\frac{1}{1.078} = 92.7$ per cent efficiency.

Generally speaking, if g is the efficiency of the fifty per cent larger polyphase alternator, the efficiency of the single-phase machine is

$$g_1 = \frac{g}{15 - \frac{g}{2}}.$$

If the power-factor is 0.85, the output of a certain machine is reduced fifteen per cent (actually the output of the armature only), while the excitation losses rise.

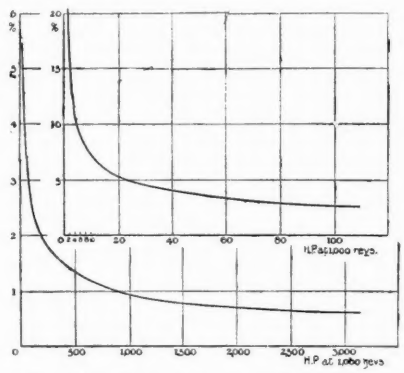


FIG. 16.—COPPER LOSS OF FOUR-POLE INDUCTION MOTORS.

It may therefore be stated approximately as

$$g_{0.85} = \frac{g}{1.3 - 0.3 \times g}.$$

I have pointed out what great influence on the size of machine the permissible voltage drop has. Therefore it is advisable not to specify it higher than can be helped. As a rule one finds about seven and one-half per cent drop specified with a power-factor of one, and twenty-three per cent with a power-factor of 0.85. Calling the excitation watts with this drop

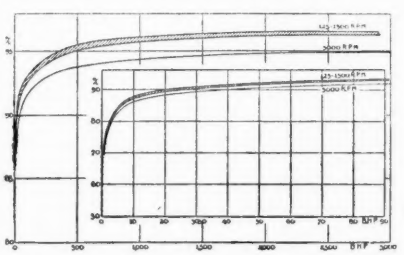


FIG. 17.—EFFICIENCY OF FIFTY-CYCLE INDUCTION MOTORS, POLYPHASE.

(twenty-three per cent) unity, and plotting a curve "exciting watts as function of the drop," the curve Fig. 13 is obtained. I have marked twenty-three per cent as normal. If five per cent less drop is required—that is, eighteen per cent—the exciting watts would go up twenty-five per cent, while an increase of five

per cent to twenty-eight per cent drop only alters the watts twelve per cent. A voltage drop of twenty-three per cent therefore appears to be very well chosen.

INDUCTION MOTORS.

The Efficiency—The design of induction motors is far more definite than that of alternators, so that I may venture to reproduce a curve for the normal flux as a function of the "power" horse-power at 1,000 revolutions in Fig. 14. The over-

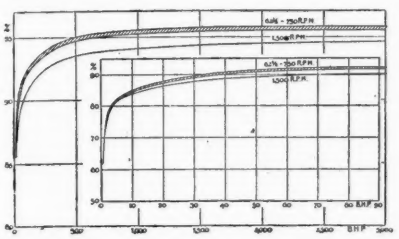


FIG. 18.—EFFICIENCY OF TWENTY-FIVE-CYCLE INDUCTION MOTORS, POLYPHASE.

load capacity is the chief determining factor for these fluxes. In our case they refer to machines for about 125 per cent overload capacity. With large and high-speed machines this figure is somewhat higher, owing to the fact that considerations of economy become important when AW and F are chosen. The percentage core loss and copper loss for different powers are shown in Figs. 15 and 16. In induction motors the percentage core loss is also independent of the speed, and of the periodicity, if plotted separately for different numbers of poles. Three curves have been drawn: for two poles,

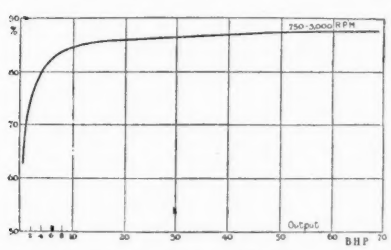


FIG. 19.—EFFICIENCY OF FIFTY AND ONE HUNDRED CYCLE INDUCTION MOTORS, SINGLE-PHASE.

sixteen poles, and forty-eight poles. For any intermediate number the method of interpolation may be used. For instance, if it is desired to find the percentage core loss of a fifty-cycle, 500-horse-power, 500-revolution (synchronous) motor, we have

$$\text{Power} = 500 \times \frac{1{,}000}{500} =$$

1,000 horse-power at 1,000 revolutions.

$$\text{Number of poles} = 120 \times \frac{50}{500} = 12.$$

From Fig. 15: Core loss with two poles, 1.4 per cent; with 4 poles, 2.1 per cent; consequently with twelve poles, 1.9 per cent.

The copper losses have been plotted for four poles and fifty cycles only. Here it has to be borne in mind that the percentage copper loss increases as the square root of the number of poles, and in proportion to the periodicity. The reason for this is that with an increasing number of poles the output falls proportionately, but the mean length of turn is reduced as the length of the end connections decreases. With different frequencies the copper losses remain constant, while the output falls with the periods. If it is desired to know the copper loss of an eight-pole machine for twenty-five cycles (375 revolutions per minute), having a "power" of 100 horse-power at 1,000 revolutions, it will be seen, from Fig. 16, that for fifty cycles and four poles it is 2.7 per cent; consequently in our case it amounts to

$$2.7 \times \sqrt{\frac{8}{4}} \times \frac{50}{25} = 7.6 \text{ per cent.}$$

This copper loss is the stator and rotor loss combined. With moderately good

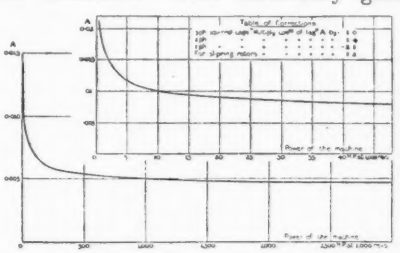


FIG. 20.—COEFFICIENT OF LAG OF INDUCTION MOTORS.

machines about forty-four per cent of the copper losses are in the stator, fifty-six per cent in the rotor, so that the rotor losses in our case are $7.6 \times 0.44 = 3.4$ per cent of the output of the machine, unless a squirrel-cage rotor with specially high resistance is employed. This 3.4 per cent may be called the natural rotor losses, or, what is practically the same, the natural slip. With squirrel-cage machines it is about twenty per cent less than this amount, which refers to wound rotors. For obtaining high-starting torque this slip can be artificially increased by the use of end rings of high-resistance metal in the rotor. I shall refer to this in the section on starting.

Figs. 17 and 18 show the complete efficiency curves for fifty and twenty-five cycles for polyphase machines. Fig. 19 gives the efficiency of single-phase induction motors for fifty and 100 cycles.

In these curves the most striking feature is the fact that the efficiency is almost independent of the speed. It has been possible to show a narrow shaded area within which the efficiencies fall for any speed between 125 and 1,500 revolutions per minute. Since the percentage core loss falls and that of the copper and friction loss rises as the speed goes up, the total losses remain nearly constant for a certain output.

A comparison will show that the difference between the efficiencies of direct-current machines and alternating-current induction motors is not considerable.

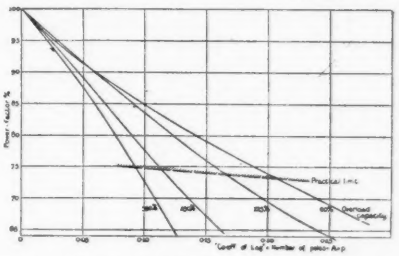


FIG. 21.—POWER-FACTORS OF INDUCTION MOTORS.

Single-phase motors naturally are considerably worse than both (Fig. 19).

The Power-Factor—In saying that the efficiencies of direct-current and induction motors are practically identical, we have to restrict this to the real efficiency, the apparent efficiencies naturally being much worse with the latter class of machines.

It is often important to know clearly beforehand what the power-factor is likely to be before deciding on the speed, as a few revolutions may often convert a bad motor into a moderately good one.

It is hardly practicable to draw a great number of power-factor curves which might enable one to read off the figures at a glance, as there are too many items

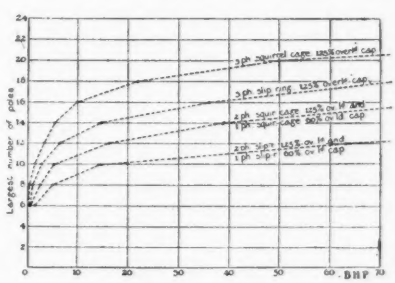


FIG. 22.—LIMIT NUMBER OF POLES OF INDUCTION MOTORS.

influencing the power-factor, namely, the size of machine, expressed by the "power" horse-power at 1,000 revolutions, the number of poles and the overload capacity. The air-gap also influences the power-factor, but, as hitherto, this detail of design is taken account of in determining the "size," that is, the power of the machine. Instead of a great number of curves for Cos ϕ we use the two Figs. 20 and 21.

It is well known that the power-factor

of an induction motor greatly depends on the leakage of the machine, this leakage being smaller the smaller the air-gap, the larger the diameter, and the lower the number of poles. Apart from this latter item the leakage only depends on details of design, so that a factor which is an expression for the tendency to admit leakage can be plotted as a function of the "power" of the machine.

We will call this factor the "coefficient of lag," A.

All details of design have been crammed into this coefficient, and it has been so selected that if multiplied by the number of poles Heyland's leakage factor appears. The meaning of A can be easily understood by studying the treatises by Behrend, Hobart, S. P. Thompson and others on induction motors.

Fig. 20 shows the coefficient of lag, A, dependent on the "power" horse-power at 1,000 for three-phase motors with squirrel-cage rotors, while Fig. 21 directly gives the power-factor at normal load for different overload capacities, dependent on

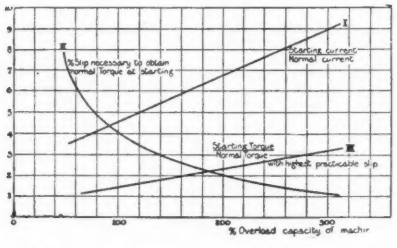

% Slip necessary to obtain normal torque at starting
Starting current ÷ Normal current
Starting Torque ÷ Normal Torque with highest practicable slip
% Overload capacity of machir

FIG. 23.—STARTING OF SQUIRREL-CAGE MOTORS, POLYPHASE.

the product "A × number of poles." If it is desired to know the power-factor of a twenty-horse-power, 500-revolution, fifty-cycle, three-phase motor, having, say, 125 per cent overload capacity, that is, a machine with $120 \times \frac{50}{500} = 12$ poles = p, and a "power" of $20 \times \frac{1,000}{500} = 40$ horse-power at 1,000, we pick out from Fig. 20 A = 0.0082; A × p = 0.0082 × 12 = 0.099. From Fig. 21 for this [A × p] and 125 per cent overload capacity the power-factor = 83½ per cent. If an overload capacity of 350 per cent were required, the power-factor would have been reduced to seventy-three per cent.

The coefficient of lag, A, in Fig. 20, referring to three-phase squirrel-cage motors, is smaller than with any other class of motor, so that three-phase squirrel-cage machines have the highest possible power-factor. A has to be multiplied by the following constants: with two-phase machines by 1.4; with single-phase machines by 2.1.

In all cases where the rotor is a wound one the coefficient of lag increases another twenty per cent. The motor in

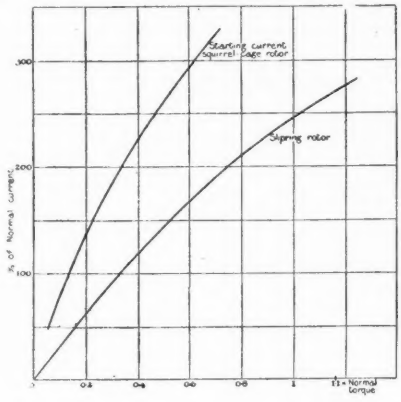


FIG. 24.—STARTING CURRENT OF SINGLE-PHASE MOTORS.

the above-mentioned example, having as three-phase squirrel-cage machine an A = 0.0082, would as two-phase slip-ring motor have an A = 0.0082 × 1.4 × 1.2 = 0.0168. A × p = 0.0168 × 12 = 0.20. With 120 per cent overload capacity the power-factor works out at sixty-nine and one-half per cent compared with eighty-three and one-half per cent as a three-phase squirrel-cage machine. I should call this an almost impossible machine, as the wattless component of the current is larger than the watt component, and the no-load current will not differ very greatly from that at full load. I have drawn a line in Fig. 21 which represents the line of desirable practical limits,

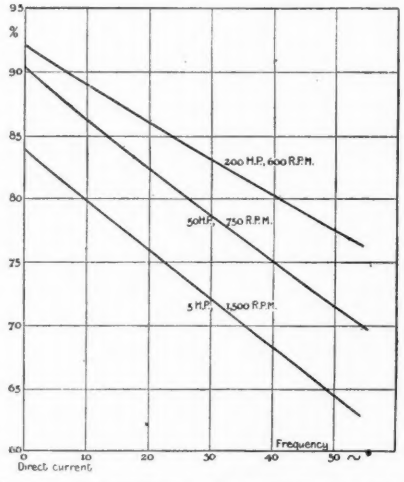


FIG. 25.—EFFICIENCY OF ALTERNATING-CURRENT COMMUTATOR MOTORS.

which only in exceptional cases ought to be exceeded. To make this still clearer the chart, Fig. 22, has been added, giving the highest number of poles a motor ought to be built for, the overload capacity being 125 per cent in the case of polyphase and sixty per cent with single-phase machines. From this chart it will be seen that a twenty-horse-power motor as three-phase squirrel-cage machine ought not to have more than sixteen poles, as three-phase slip-ring not more than fourteen poles, as single or two-phase squirrel-cage not more than twelve poles, as single or two-phase slip-ring not more than ten poles.

This is rather hard on single-phase 100-cycle motors, but these are troublesome machines in many other respects. They can, however, be built if one is cautious in the selection of speeds. By building specially narrow 100-cycle motors the performance may be slightly improved.

It is necessary to point out that, when finding the coefficient of lag for single-phase motors from Fig. 20, this is to be taken as an abscissa for fifty per cent larger output, as the "size" of a single-phase machine is fifty per cent larger than the corresponding three-phase one.

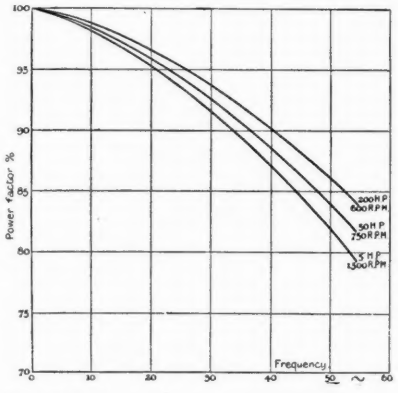


FIG. 26.—POWER-FACTORS OF ALTERNATING-CURRENT COMMUTATOR MOTORS.

The Starting of Polyphase Squirrel-Cage Motors—The starting performance of a slip-ring motor where resistance is inserted in the rotor is too well known to be mentioned here, and it does not offer any special points which depend on size or design.

The starting of squirrel-cage motors, however, often causes uncertainty as to the current consumption and the torque obtainable.

We have to distinguish between machines being thrown straight on to the line and those started by means of a starting transformer, which reduces the voltage on the motor terminals.

If thrown straight on to the line, the current taken by the motor depends on the overload capacity it has been designed for, the current being larger the stronger

the motor. Fig. 23 shows in a curve the approximate ratio $\frac{\text{starting current}}{\text{normal current}}$ dependent on the overload capacity. With very bad machines this ratio is somewhat smaller than that given here, due to the high no-load current. It will be noticed that with 125 per cent overload capacity the starting current is about five times the normal current. If we wish to obtain a starting torque equal to the running torque, the rotor must have its resistance adjusted to give the percentage of slip as shown by Curve II in Fig. 23.

In some cases, especially with American machines, a good efficiency is not regarded as of great importance compared with good starting qualities. Also, short-circuit rings of the squirrel-cage are made of very high resistance metal, and slips of six and, with small machines, even ten and twelve per cent are considered quite permissible. In this case very high starting torques can be obtained. Curve III shows about the highest starting torque practicable. For instance, a machine with 150 per cent overload capacity, having a starting current of five and three-quarter times the normal, can be expected to develop about 1.9 times the normal torque at starting.

If in this case the normal torque is required a starting transformer can be used, cutting down the starting current in the ratio $\frac{1}{1.9}$ to $\frac{1}{1.9} \times 5\frac{3}{4} = 2\frac{3}{4}$ times the normal.

Very often the windings are switched in star connection at starting, being in delta at normal load, in order to reduce the starting current. Then the starting currents are reduced, together with the torques, to one-third of the figures given in Fig. 23. A motor having 200 per cent overload capacity, the starting current being six and three-quarters, and the starting torque two and one-quarter times the normal, would, in the star-delta method of starting, develop a torque of $1\text{-}3 \times 2\frac{1}{4} = \frac{3}{4}$ normal torque, and would consume $1\text{-}3 \times 6\frac{3}{4} = 2\frac{1}{4}$ times normal current.

Starting of Single-Phase Motors—Single-phase induction motors with slip-rings are as a rule started with choking coils, and squirrel-cage machines with resistances as a means of splitting the phase. Only rarely are condensers employed.

Whatever means are used for phase-splitting, certain practical limits are encountered which without very much difficulty may also be followed up theoretically. I have given in Fig. 24 the starting current of single-phase motors as a multiple of the normal for different starting torques, the overload capacity being assumed to be about seventy-five per cent.

Maximum Voltage—Before concluding the section on induction motors I would like to allude to a question often asked, What is the maximum voltage for which a motor can conveniently be built? When ought a transformer to be used with the motor? This naturally depends very much on the design. Often the end brackets are too tight to take very high-voltage end connections, and questions of detail of design have to be taken account of. If this is not the case, I may say that the voltage of an induction motor ought not to be so high that with large machines the current falls below two and one-half amperes and with small machines below one and one-half amperes.

SINGLE-PHASE COMMUTATOR MOTORS.

The real efficiency of a single-phase commutator motor is generally worse than that of a similar machine of the induction type, though the efficiency of the latter is not particularly good. The cause of this is chiefly to be attributed to the losses in the resistance connections between armature winding and commutator lugs and to the enormous core loss taking place in the whole body of the machine. These losses are particularly high with high frequencies, and this is one of the reasons why generally the frequency of single-phase motors is kept as low as possible, so that actually its performance approaches that of direct-current machines. But naturally the performance of an induction motor would also be excellent at very low frequency, though it would under no condition approach the perfect behavior at starting of the commutator motor.

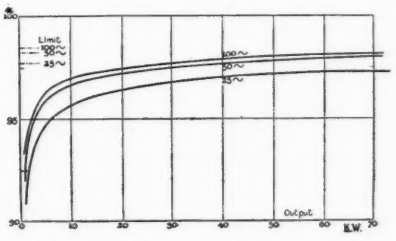


FIG. 27.—TRANSFORMER EFFICIENCIES.

As characteristic motors I have chosen a small, a medium and a large machine—five horse-power at 1,500 revolutions per minute, fifty horse-power at 750 revolutions per minute, 200 horse-power at 600 revolutions per minute—and efficiencies and power-factors have been plotted as a function of the periodicity (Figs. 25 and 26). It must be borne in mind that these curves do not represent tests on one machine, say a machine designed for twenty-five cycles and run at different frequencies; but the fifty-cycle machine is to be considered as a design entirely different from the twenty-five-cycle one, each being built so as to form the best machine for its special conditions.

The power-factors of Fig. 26 are those of plain single-phase commutator motors with compensating winding. They may be improved by using machines of the Latour and Winter-Eichberg type or by applying special means of other kinds to raise the power-factor, generally at a sacrifice of one or two per cent in the efficiency.

TRANSFORMERS.

Transformer efficiencies at normal load only do not always serve very well as an indication of the real quality of the apparatus, less so than in the case of the average motor and dynamo. This is true, at all events, with lighting transformers. With power transformers the normal efficiency is quite a useful figure.

The efficiencies plotted in Fig. 27 are not the normal but the maximum figures obtainable from a certain transformer—that is, when core and copper losses are equal. Usually it is possible to shift this maximum somewhat, putting it with lighting transformers near half-load, with power transformers near full load. By stating the maximum efficiency only, the curves in Fig. 27 will prove useful, even for finding efficiencies at very small loads, if one takes account of the fact that one-half of the losses are core losses and the other half copper losses, which vary as the square of the output.

I have not extended the scale of the kilowatt beyond seventy kilowatts, as such a transformer as a rule has as good an efficiency as a 700-kilowatt one. The following may be given as efficiency limits: 100-cycle transformers ninety-eight and one-half per cent, fifty-cycle transformers ninety-eight and one-quarter per cent, twenty-five-cycle transformers ninety-seven and three-quarters to ninety-eight per cent.

It was my intention to deal also with special machines as boosters, induction motors with pole-changing devices, motors for accelerating heavy loads, and others; but I feared that by introducing further developments and theories in this direction it would only tend to divert discussion from the main question, What is the normal performance of an ordinary machine?

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Recent Developments in Electrolytic Cells.

A brief description is given here by H. S. Renaud of several of the newer electrolytic cells intended particularly for the electrolysis of salt. A feature of these cells is the reappearance of the diaphragm. One cell of this type, which is now being tried in Europe, is the Billitzer cell. In this the old idea of combining the principles of the gravity and diaphragm types is revised, but with certain modifications. The apparatus consists of a bell closed by a diaphragm formed of a screen of nickel or iron, on which is laid asbestos, which is in turn covered with a precipitated layer of a mixture of barium sulphate and divided asbestos. This diaphragm is said to last for months, and is easily renewed. The permeability is regulated by the proportion of the sulphate and asbestos and the thickness of the layer. The anode is of platinum or carbon and is inside the bell, a short distance from and parallel to the diaphragm. The salt solution is charged into the bell and is allowed to accumulate until it just wets the cathode; it then overflows through an outlet. The wire screen, which serves as the cathode, is slightly bent so as to permit the escape of hydrogen. During electrolysis the salt solution is admitted continuously through a supply pipe. As the upper stratum becomes diluted the lower stratum is more concentrated, and this is made to flow out over a dam and into the cathode chamber. The working voltage of this cell is from four to five, and the caustic liquor produced contains about twelve per cent of sodium hydroxide with yields of eighty-five to ninety-five per cent. The chlorine runs about ninety-nine per cent. The current density is fifty-six amperes per square foot, and the temperature is about sixty degrees centigrade.—*Abstracted from the Engineering and Mining Journal (New York), February 22.*

Accumulator-Driven Electric Barges.

Several plans for improving the traffic on canals have been tried abroad, particularly in France and in Germany. The system described here is one of the later attempts to find a plan suitable to fill a special need. This was the demand for improved service between the brick fields of Brandenburg and Berlin. Hitherto this traffic has been conducted exclusively by the ordinary type of canal barge moved either by animal towage or by rowing; tugs are seldom used, as they have been found to be more expensive. The Brandenburg brick fields are about fifty miles from Berlin, and the journey by the old method required about six days each way. This, including the time required to load and unload, extended the round trip over about four weeks, and the long delay at the quays, due to handling the bricks by hand, caused a good deal of congestion and delay. The improvement introduced consists in the substitution of accumulator-driven electric barges for the old type. These are made of iron, are driven by electric motors driving a propeller drawing its energy from a battery of storage cells. At Brandenburg and at Berlin electric cranes have been installed to facilitate loading and unloading. The bricks are placed in large boxes convenient for handling by the cranes. In this way the length of the boat's stay beside the wharf is considerably reduced. While running they make from two and one-half to three miles an hour, which has been found to be the most economical speed. The motor is placed in the stern, the propel shaft being short. It runs at about 100 to 120 revolutions a minute. Forward of the motor room is the helmsman's cabin; forward of which is the battery room. The battery weighs about ten tons and is sufficient to propel the boat from one end of the route to the other. At Brandenburg and at Berlin plug boxes are provided on the public supply, which enable the batteries to be recharged while the barge is loading and unloading. The new system has reduced the round trip, including loading and unloading, from four weeks to one week. Four days are actually used for traveling, the others for loading and unloading, delays, etc. These barges have a larger carrying capacity than those they replace, and each boat makes many more trips than the older ones. This system has been in operation about a year and has been profitable.—*Abstracted from the Engineering Times (London), February 6.*

An Italian Water-Power Station.

A short description is given here of an interesting water-power station at Trezzo. This is one of the most important installations of its kind in Italy. The station building is situated close to the old Castle of Trezzo, on a narrow peninsula of land, around which flows, in a sinuous course, the river Adda. There are no separate intake works nor canal nor pipe-line, as the power-house is on the river bank itself, a short distance above the dam. The water, after passing through the low-fall turbines, is taken through a pair of tunnels, about 300 feet long, and discharges on the other side of the peninsula into the river, making a fall of from eighteen to twenty-five feet available. The initial equipment at the station consists of nine 1,000-kilowatt generating sets with the necessary exciters. Three more generators will be added later. Ten of these will deliver alternating current at forty-five cycles; two will deliver fifty-cycle current. Each unit consists of two water-wheels, mounted one above the other, on the same vertical shaft. One of these takes the water from below and the other from above. The lower wheel takes part of the weight of the revolving system. The upper wheel has the pressure of the water between its runner and the top of its case lightened by means of a siphon tube. The rotors of the alternators are coupled directly to the turbine shafts and are supported from bearings at the top. They are of the internal revolving-field type with a stator diameter of nineteen feet. Each machine is constructed in two parts and is carried on six feet. There are two bearings; the top being a thrust bearing, while the lower serves simply as a guide bearing. The total weight of the revolving mass is twenty-four tons. The stator core is constructed with open slots. The forty-two-cycle generators are wound for 13,800 volts, and the fifty-cycle machines for 7,000. A supplementary steam plant, consisting of four 1,000-kilowatt sets, driven by horizontal steam engines, has been installed to make up for the deficiency of water during the winter

months. The switchboard of the station is of the usual cellular type.—*Abstracted from Electrical Engineering (London), February* 13.

Greenock, Scotland, Refuse-Destructor Plant.

On February 7 the combined refuse destructor and electric plant of the town of Greenock, Scotland, was put into service. The building of the plant is laid out in four bays, the destructor furnaces occupying that nearest the street. This is 110 feet long, forty feet wide and forty-one feet high. The central two bays accommodate two sets of boilers for the destructors and coal firing respectively, while the remaining bay forms the engine room. The destructor consists of six large cells and combustion chambers, with three water-tube boilers arranged so that each pair of cells, with its boiler, can be worked independently. The cells of a pair are fired alternately so as to maintain a steady steam pressure. The combustion chamber is thus kept at a high temperature to burn thoroughly all gases escaping from a fresh charge. The furnace grates have an area of twenty-five square feet and are constructed so as to burn efficiently a full cartload of refuse at one charge. The grate bars are perforated with a large number of small holes, through which a high-pressure air blast is forced by means of electrically driven fans. These fans are driven by variable-speed motors, the controlling switch of which is mounted at the boiler, and a stopping and starting switch is attached to the furnace door so as to stop the fan automatically whenever the door is opened. The inlets of these fans are carried to the under side of the storage platform, so that all the dust and fumes emitted during the process of clinkering are driven into the furnace. Auxiliary steam jets are provided for furnishing the blast in case a fan should be disabled. The refuse is delivered in carts and discharged by means of a large funnel into storage tubs. The latter are then lifted to the storage platform by an electric crane. When they are to be emptied they are lifted by the crane and placed on a movable cradle, which carries them down to the furnaces. As they are run down an incline, the top of the destructor is automatically lifted off and the lower edge of the cradle descends into the mouth of the charging doorway. Hinged doors at the bottom are then opened and the entire charge falls directly into the furnace and spreads over the grate. The whole process requires but a minute and the furnace doors are opened but a few seconds only. The boilers are of the Babcock & Wilcox type and are fitted with economizers and superheaters. Both electrically driven and steam-driven pumps are provided, and a large water-softening and de-oiling plant has been installed. In the engine room there are two direct-connected reciprocating engines of the vertical type, one driving a 750-kilowatt generator, and the other, two machines each of half this rating. The former delivers current at 500 volts, and each of the smaller generators at 250.—*Abstracted from the Electrical Engineer (London), February* 14.

Some Reflections on Railway Electrification.

The year 1908 will, says Philip Dawson, be memorable as the one during which the single-phase system was first put into regular operation on the South London line of the London Bridge railway, as well as that in which the Midland Railway Company will start a similar system on the Lancaster-Heysham branch. The author then reviews briefly the special features of the three electric railway systems. One of the disadvantages under which the direct-current system operates in England is the necessity of employing two insulated rails on account of the Board of Trade's voltage-drop regulations. This adds to the cost of the track and danger and in some cases renders this system impossible of application. There are some electrical engineers who do not appear to appreciate the fact that the difference between the single-phase and three-phase systems is at least as great as that between the three-phase and continuous-current traction. In this connection it may be pointed out that there is not a single example of the three-phase system adopted in order to handle heavy suburban traffic such as that which exists on the District and Metropolitan railways at London, or such as must be handled on the suburban lines of the great English railways. For long-distance service, where acceleration is not of importance, the three-phase motor has given and will continue to give excellent results. The single-phase system, on the other hand, has been adopted on a large scale and under peculiar difficulties in the United States, and the Prussian Government has also decided to use this system for the suburban lines at Hamburg, and it now intends to convert the entire suburban railway system in and around Berlin to the single-phase system. This involves about 200 miles of route and an expenditure of $10,000,000. The following considerations show how far existing conditions warrant the belief in the future of railway electrification and indicate what are the peculiar fields in which it may be expected to prove most useful. For practical purposes there are three causes which have or will bring about electrification. They are: Costly fuel and cheap water power, the prohibition of the use of steam, and to enable a better utilization of existing track and terminal facilities. The first consideration is the one which is bringing about the electrification of the Swedish system of railways, and to it is attributed the conversion of the Valtellina line in Italy. When electrification takes place for this reason it will be over long distances and for all sorts of traffic. When it becomes advisable to abandon steam in consequence of tunnels or cities, it is generally the case that the haul is short and stops are numerous and the traffic heavy. In such cases but two systems are available, the continuous-current and the single-phase. Up to the present time but two roads in England have been electrified in order to increase the track facilities. These are the Northeast Tynemouth electrification, and Lancashire & Yorkshire, Liverpool & Southport line. The results in these cases have been satisfactory, but the conditions are not those existing in and around London. It is pointed out that it is not safe to reckon on merely a reduced operating expense from electrification. The real object of the conversion should be to increase the carrying capacity of the road and the earning capacity of the system. Unfortunately, not all railway companies seem to appreciate this, and they are not making provision to meet the competition of the extended street-railway systems. This is particularly true in England, where the companies are attempting to decrease their expenses by reducing their local services. No partial remedy of this kind can possibly prove effective. There are but two solutions which can be maintained as correct: one is to abandon entirely the whole suburban traffic—that is to say, to give up running all local trains which stop within fifteen miles of the London termini; but this would seriously affect the incomes of the road. The more rational course would be to find some means of increasing traveling facilities without increasing working costs. This would not only meet the present competition, but would create new traffic.—*Abstracted from the Electrical Review (London), February* 14.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

The New American-Ball "Angle-Compound" High-Speed Steam Engine.

The American Engine Company, Bound Brook, N. J., has developed a new and most interesting type of high-speed steam engine, the culminating work of a lifetime of development by F. H. Ball, the well-known engine designer, and his son, F. O. Ball. Several views of this engine are shown herewith.

The designers have consistently held to the idea that a compound engine of simple design is vastly more economical of steam than any simple engine, even with the most complicated and steam-saving valve gear. In the present engine the designers have sought to attain the extreme of simplicity and fewness of parts.

The general plan of combining a horizontal engine and a vertical engine so that both shall work on the same crank-pin is not new, but a number of the desirable features appertaining to this construction have not been appreciated for high-speed engines of the single-valve type.

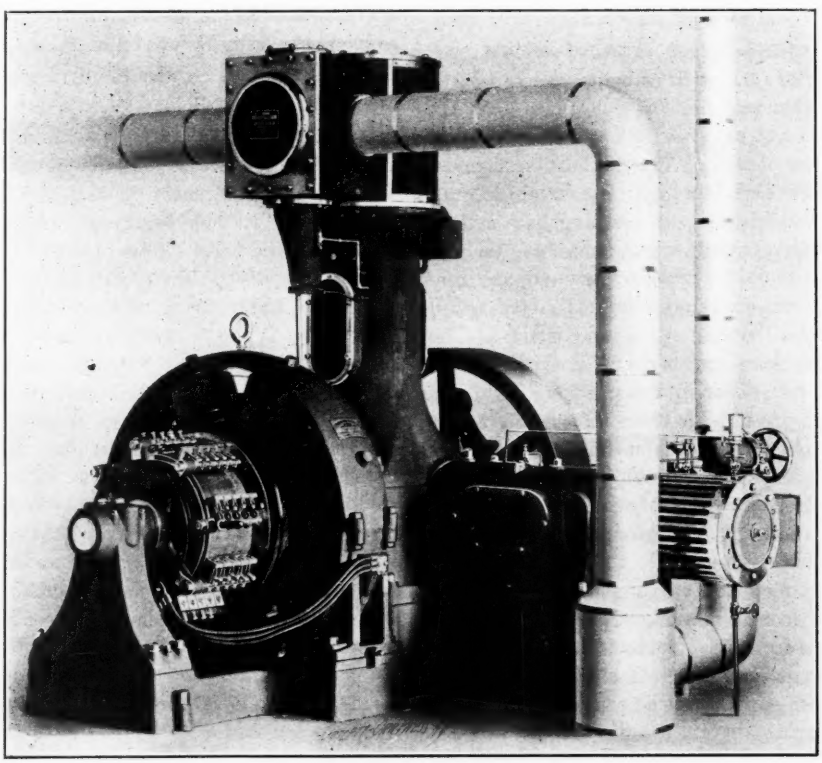
The effect of counterbalancing has been kept in mind, and by combining the horizontal and vertical engine on the same crank-pin, the total amount of horizontal thrust has been neutralized by counterbalance. When the counterweight is in a vertical plane it is opposed by the reciprocating parts of the vertical engine, so that at four points of the stroke a perfect balance is realized. Between these four points there is no position of the crank where any appreciable unbalanced condition is found.

These conditions for perfect balance are brought about in the "Angle-Compound" engine by making the low-pressure piston a very light, conically shaped steel structure of about the same weight as the ordinary cast-iron piston in the high-pressure cylinder. The low-pressure engine is made the vertical engine because it is thought desirable to have the larger piston rest on the piston rod, rather than to drag in a horizontal cylinder.

Reference to the illustrations herewith will show that the high-pressure valve is driven by the usual valve gear and shaft governor, and the low-pressure by an eccentric which is enclosed in an oil-tight casing and connected with the oil-circulating system of the engine. From this eccentric a rod drives direct to the low-pressure valve stem, which is guided by a cross-head carried in guides, as shown. This cross-head and guides are also included in the oil-circulating system. The oil-circulating system is similar to that used on the American-Ball engines, except that the oil is pumped directly to the gravity storage tank on the low-pressure frame, which is kept constantly overflowing by the supply delivered to it from the pump.

A double stuffing-box on the valve stem and bulkheads and stuffing-boxes on both piston rods prevent any water drip from mingling with the oil-circulating system. The water drip from these stuffing-boxes is carried off by concealed piping, so that the engine frame never presents an untidy appearance.

Another departure made in this engine is in the arrangement of the cross-head and guides, which are of the bored type. The cross-head is a single piece without the usual adjusting shoes, while the guides are made adjustable. These guides are carried in bored seats, and a projection from the back of the guide fits between the supports so as to resist end thrust. One of the guides is secured to the support by screws, and is only adjustable by means of shims; but the other has a pair of screws at each support to provide for delicate adjustment. The guide is securely held against these adjustment screws by a bolt that locks the adjustment securely when set up.



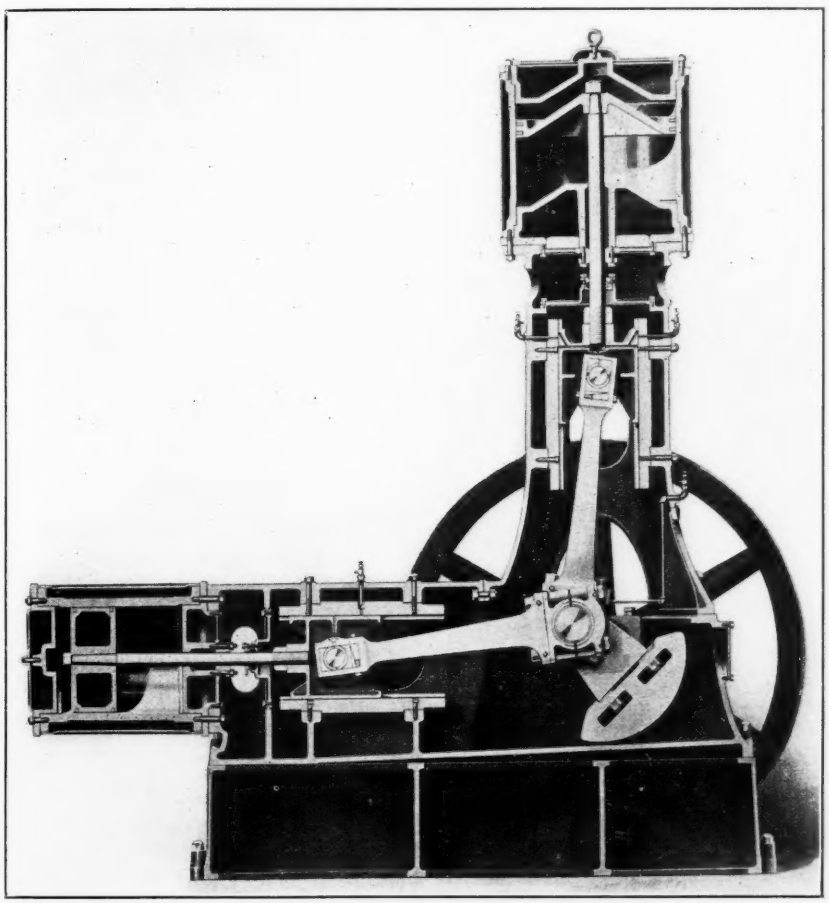
VIEW OF AMERICAN-BALL "ANGLE-COMPOUND" HIGH-SPEED STEAM ENGINE.

The crank-pin is double the usual length, and the connecting rods are placed side by side on this double-length pin.

The builder claims that this type of engine runs more smoothly and with much less strain and shock than any other form of high-speed engine because of its perfect balance and because it has four small impulses on the crank at each revolution, instead of two large impulses.

A 160-horse-power engine with an eleven-inch stroke, running at 300 revolutions per minute, and direct-connected to

an American-Ball generator, has recently been installed in the company's power plant at Bound Brook. This engine has no special foundations, except the concrete floor of the building, and, it is stated, is not tied down with a single foundation bolt. It is also stated that a new full-length lead pencil was placed on the horizontal cylinder head and then on the vertical cylinder head, and there was not vibration enough to disturb the balance of the pencil, even with a fluctuating load on the engine.



Sectional View of American-Ball "Angle-Compound" High-Speed Steam Engine.

In floor space, the combining of the horizontal engine with the vertical gives a great saving for the same amount of power. The cost of foundations is also reduced.

For large powers these engines combined in pairs, with the generator or belt-wheel beneath them, make an exceedingly compact unit. In these combinations the engines are used as double compounds when run non-condensing; or, where condensing water is available, as four-cylinder, triple-expansion engines. In the latter case one horizontal engine is the high pressure, the other horizontal the intermediate pressure, and the two vertical engines combined are the low pressure, thus giving a large area of low-pressure piston without using any pistons of very large diameter.

The American Engine Company reports that the increased business consequent upon the manufacture of these new engines has necessitated a large addition to its plant at Bound Brook, where it has for some weeks been running both day and night shifts.

Termination of Westinghouse Lamp Company Receivership.

The Westinghouse Lamp Company announces that the New Jersey and New York circuits courts have ordered the discharge of the company's receivers and the return of the property to the stockholders. These orders became effective March 1, and after that date the management of the company will be conducted by the executive officers as prior to the receivership.

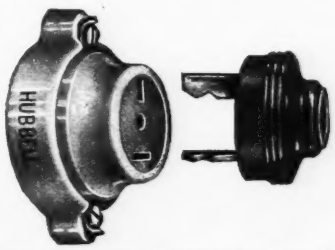
The business of the company has been carried on at a considerable profit during the receivership and there has been no cessation in the development and factory operations.

The new factory of the company at Bloomfield is now in operation and arrangements are being made to concentrate all of the manufacturing at that plant. The output of this admirably adapted plant will be about 15,000,000 lamps annually.

Hubbell Polarity Flush Receptacles and Wall Plugs.

Many special features are claimed for the new twenty-ampere flush receptacles and wall plugs made by Harvey Hubbell, Incorporated, of Bridgeport, Ct.

While they embody the essential features of the Hubbell three-ampere plugs,

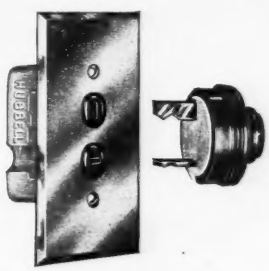


Hubbell Polarity Receptacle and Plug.

including the convenient interchangeable cap, the porcelain parts and contacts are larger and stronger, to insure absolute safety for carrying 250 volts.

They were designed primarily for use with motors and the larger types of heating and cooking apparatus, but their utility is not confined to these fields of service.

The contact posts being set at right angles, they can enter the receptacle but one way, and reversal of polarity is impossible. This feature makes them especially desirable for use on electrical indicators and experimental apparatus,



Hubbell Polarity Flush Wall Plug and Receptacle.

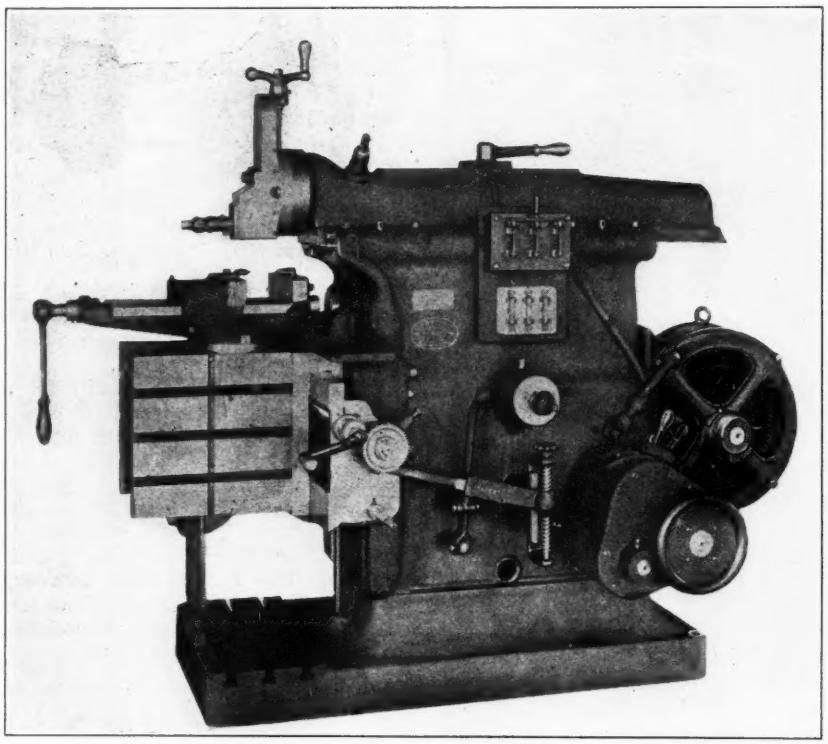
whose accuracy depends upon a constant and unvarying flow of current.

The flush receptacles fit standard switch boxes. To prevent marring, the plate may be readily removed and replaced after wall decorations are complete.

The concealed, cleat and molding wall plugs are commended as handy and reliable accessories for electrically driven machinery and tools. A snug-fitting metal casing covers the interchangeable cap, protecting the inner parts and making the whole practically indestructible.

Eberhardt Motor-Driven Shapers.

Gould & Eberhardt, of Newark, N. J., have kept abreast of rising requirements and have been among the pioneers in advancing changes to meet modern necessities. In keeping with this policy, their line of shapers has been redesigned, each machine being made larger and heavier in the working parts, and power, strength, speed and rigidity added to obtain the fullest possible benefits from the new high-speed cutting steels. The application of the electric motor to its shapers has, however, demonstrated more than anything else the up-to-date methods of this company. The motor-driven shaper



GOULD & EBERHARDT SHAPER DRIVEN BY ALLIS-CHALMERS TYPE "AN" INDUCTION MOTOR, WITH SPEED CHANGES EFFECTED THROUGH GEAR BOX.

is by all means the most economical, for the long lines of shafting, countershafting, belting, pulleys, etc., with their incidental losses and waste of power, have been eliminated. Another point in favor of motor drive is the convenient and rapid method it affords for quickly adjusting the machine to suit the work. Gould & Eberhardt have used for the shaper illustrated an Allis-Chalmers induction motor, which is connected by means of a silent chain drive enclosed in a guard. In connection with the advantages of quick speed change enjoyed through the use of the motor, a clutch and brake device is furnished for instantly stopping the machine without stopping the motor. This feature not only saves time in setting, adjusting and inspecting the work, but also saves wear and tear on the motor from frequent stopping and starting, the latter running continuously while the job is in machine.

A New High-Voltage Metallic-Filament Lamp.

It is announced in the *Electrical Times*, of London, England, for February 13, that the Bryant Trading Syndicate, Limited, has increased its capital in order to enable it to increase its factory at Horsell Road, Highbury, where the manufacture of metallic-filament lamps under the Harrison inventions will be begun. These lamps will range in steps from seventeen candle-power at 100 volts to thirty-five candle-power at 250 volts, all at an efficiency of one and one-quarter watts per candle. A smaller lamp, rated at eight candle-power for 100 volts, will be put out, the consumption of which will be one and three-quarters watts per candle. These lamps, it is said, will burn in any position, and are suitable for either direct or alternating currents. One feature is the use of a bulb a little larger than the standard size.

Westinghouse Machine Company.

The business of the Westinghouse Machine Company during the month of February has continued to show the most encouraging signs of improvement. Quite a number of excellent orders have been received recently in the various departments. There is as a result much greater activity in the shops at East Pittsburg. Last week unusually large shipments were sent from the works on export delivery, including several large steam engines. One of these shipments, consisting of five 125-horse-power compound engines, was consigned to Takata & Company, the Japanese agent of the Westinghouse Companies in Tokio, for delivery to a manufacturing plant in Canton, China. Another compound engine of 500-horse-power capacity, also included in this shipment, was consigned to the same firm for delivery to the Southern Japanese Railway Company, of Kaisha, Japan.

The receivers of the company are reporting very encouraging progress with the plan of rehabilitating the company, and it is now expected that its affairs will again be in the control of the stockholders within a very few days.

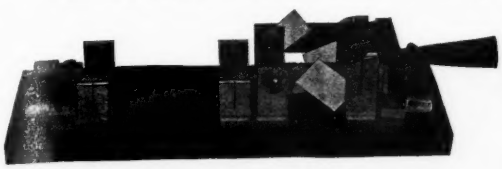
The Mechanics' Institute.

Among the trade schools where a course in practical engineering is enabling young men to secure an education which will fit them to advance in their chosen trades, the Mechanics' Institute, at 136-140 West Twenty-third street, New York city, is an exceptional example. A fine four-story building has been equipped with its own power and electrical and mechanical departments, and all of the apparatus is devoted to the use of the students. The equipment includes mechanical appliances, tools, devices, measuring instruments and laboratory apparatus. The students are taught the practical applications of alternating-current and direct-current motors and dynamos, are given instruction in lighting and illumination, undertake interior wiring, are taught the construction of electrical machines and devices, and also gain experience in the laying out and operation of alternating-current and direct-current power plants.

The director of the institute is W. M. Murphy, a mechanical and electrical engineer well known in electrical circles, who has gathered about him a staff of electrical engineers as instructors. There is also an advisory board which plans the work of the faculty.

The Selection of Knife Switches.

The Trumbull Electric Manufacturing Company, Plainville, Ct., has published recently some interesting data bearing on the selection of knife switches. While knife switches occupy a comparatively small corner when the electrical field is considered as a whole, and consequently do not receive much detailed attention,



ILLUSTRATING THE WEAK POINTS OF A KNIFE SWITCH.

this line of material really deserves careful consideration upon the part of the purchaser. As a rule, he has not the time to examine minutely into the merits of his switches, and rather takes it for granted that, where a guarantee is furnished, the switches do not depart materially from general fitness in construction.

In carrying out the idea of indicating some of the places where knife switches

TRUMBULL TYPE "A" SWITCH.

may fail, the Trumbull company calls attention to the accompanying illustration, which shows some of the defective contacts. It will be noticed that a paper three-quarters of an inch wide can be inserted all the way across the lower part of the left-hand jaw contact. On the right-hand contact a Bristol-board business card

TRUMBULL TYPE "C" FUSED SWITCH.

is inserted for three-quarters of an inch. This lack of care in assembling explains why twenty-five per cent to fifty per cent of contact surface is sometimes lost, and shows where a switch may easily, and sometimes dangerously, heat up. Where the washers at the hinge are of iron, copper-plated, and do not have the necessary spring to keep the posts in close adjustment with the blade, this is liable to happen. Where bolted contacts are not used between the lugs and foot-pieces, and where the contacts are furnished with rough cast lugs just as they come from the foundry, a good deal more of the carrying capacity is lost. The lugs should be machined so as to make intimate contact. Again, the lugs should not overlap the foot-pieces, as saving of copper in this respect does not allow the full carrying capacity.

Another fault common to cheaper forms of knife switches is the use of fibre which is too thin, and sometimes the reinforced blade is trimmed down to dimensions which makes it liable to break down.

Another feature which is very advantageous in the Trumbull switch is the elimination of middle screws in the handle bars. This renders the fibre little likely to break down and gives a strong, rigid bar for the handling of the switch.

One of the illustrations herewith shows also the Trumbull type "A" switch, and the other the type "C" fused switch.

Remarkable Performance of Gem Lamps.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Some time since the writer made a number of tests on the new metallic-filament lamps, and the result of a "shop test" on "Gem" lamps is very interesting, especially since these lamps are not recommended for use on circuits with wide variations in voltage. The lamps were ordinary stock "Gem" metallized filaments, in no way specially selected except for a certain "top" and "lower" voltage. These were:

"Top" voltage	120
"Middle" "	118
"Bottom" "	116

When new the average candle-power and total wattage of these lamps when burned at the above voltage was:

		Candle-Power.	Watts.
"Top" voltage	120	20	50
"Middle" "	118	18	48
"Bottom" "	116	16	45

The test was made to determine the advisability of using a lamp of the "Gem" type for mill work. The "shop test" was made by installing the lamps upon the same circuit to which they would be attached when performing their regular service in the mill, and burning constantly for 800 hours. They were subject to considerable vibration and a variation in voltage from 115 to 127 volts, or about fifteen per cent. The results follow:

60 per cent of the lamps burned the 800 hours.
10 " " " " out in 700 hours.
10 " " " " " 600 "
20 " " " " " 500 "

The average candle-power and wattage of those lamps which had burned 800 hours was as follows:

At the "top" voltage (120):
16.5 candle-power, 47.5 watts.....2.88 watts per candle.
At the "bottom" voltage (116):
13.9 candle-power, 44.6 watts.....3.2 watts per candle.

These results are extraordinary for several reasons.

First—The lamps being selected to give twenty candle-power at the "top" voltage (120), their useful life according to the manufacturers' rating is 470 hours, at the end of which time the candle-power would be eighty per cent of the candle-power when new. But here we have lamps operating at times on an increase in voltage of nine per cent, and yet they lived nearly twice as long as their rated life, and at the end of the period mentioned the candle-power had not diminished anything like what might have been expected.

Second—Serious vibration in a great many cases has caused "Gem" lamps to burn out early. It was expected in this instance that a very large percentage of the lamps would burn out in a few hundred hours, but, as shown above, all lamps lived at least what would be considered a reasonable number of hours, under the conditions.

Third—The lamps which lived the 800 hours showed very little blackening of the bulb. This is one of the great advantages of the "Gem" lamp and is one reason why it should appeal strongly to the user of incandescent lamps.

The performance of the "Gem" lamp in this test should be interesting to those who have been and are advocating its use, for it goes to show the wonderful possibilities of this type of illuminating unit.

GEORGE W. FOWLER.

New York, February 28.

Rockford Edison Company Entertains.

The Rockford Edison Company, of Rockford, Ill., gave its first annual dinner to the allied electrical interests of Rockford on Thursday evening, February 20. This affair, the first of a series which the company will tender to its patrons and friends, was a distinguished success, and the Edison company is in receipt of many commendations for its public-spirited policies and its determination to assist in carrying out the slogan of the town, "Watch Rockford Grow."

The principal speaker of the evening was J. Robert Crouse, of the Co-operative Electrical Development Association, Cleveland, Ohio. Mr. Crouse was introduced by the toastmaster, J. Stanley Browne, and he elaborated on the progress of the co-operative development idea and explained the motives and function of the organization.

Addresses were also made by E. E. Bartlett, D. S. Schureman, George D. Roper, Edward F. Pendergast and F. H. Golding, manager of the company.

Current Electrical News

DOMESTIC AND EXPORT.

MEXICAN ELECTRICAL NOTES—Belgian capital is said to be concerned in the plans for the reopening of the famous Cuale mining district in Guadalajara, Mexico, the generation of electric power and the construction and operation of an electric line from Cuale to the Pacific port of Las Penas. Luis H. R. von Ruecau, a mining engineer who has secured several old mines and considerable virgin mineral land in the Cuale district, and who holds a water power concession on the Ameca and Mascota rivers, is representing the Belgian capital.

COMMONWEALTH EDISON COMPANY TO ENLARGE SYSTEM—The Commonwealth Edison Company is about to begin the construction of another addition to the $6,000,000 generating plant which it is building on the south branch of the Chicago River. The new building will be three stories high and will cover an area of 260 by 208 feet. It will be located at 2438 to 2474 Twenty-fifth street. Plans for the building were prepared by Architects Shipley, Rutan & Coolidge. The contract has been let to the Wells Brothers Company. The building and equipment will cost $750,000.

ELECTRIC ROAD CHANGES HANDS—A deal is stated to have been made whereby Jay P. Graves, of Spokane, Wash., head of the Inland Empire system, is to acquire the property, rights and franchises of the Lewiston & Southeastern Electric Railroad Company which has projected a line from Lewiston to Waha, Westlake, Nezperce and Grangeville, through a rich section of country. It is said Mr. Graves will secure all the franchises and terminals of the electric line in Lewiston. Mr. Graves will also acquire the rights and property of the Salmon River Development Company, the plans for which provide for the installation of a large power plant on the Salmon River.

McKINLEY SYSTEM TO BUILD NEW LINE—Plans are now in the making by officials of the McKinley system for the building of an interurban line between Peoria and Streator, Ill., which, when finished, will be the connecting link of a cross-country electrified railway between Chicago and St. Louis. The new route proposed will carry the line from Peoria out across the new McKinley bridge, already used by the Illinois Traction Company for the Peoria-Bloomington division of the system. It is to extend to Washington, and then on to Streator. From Streator it will head north, and either tap the McKinley system already built at Ottawa or at Seneca, where the lines extend to Joliet. From Joliet it will be an easy matter to connect the lines with Chicago, as several propositions are open, or a new line will be constructed.

LONDON'S ELECTRICAL SUPPLY—An interesting report, giving an excellent idea of the great amount of electricity used in the metropolitan police area of London, England, for power, heating and public and private lighting last year, has been issued by the board of trade. The municipal authorities supplied 28,281,320 units for power and heating, 42,934,965 units for private lighting, and 16,578,716 for public lighting, the cost per unit, respectively, being 1.301*d*., 3.677*d*. and 1.850*d*., a total of 87,795,001 units supplied at an average cost of 2.563*d*. The companies were responsible for the supply of 38,006,198 units for power and heating, 82,995,205 for private lighting and 4,377,875 for public lighting, charging for such supply 1.45*d*., 3.833*d*. and 1.62*d*. per unit, respectively, altogether 125,379,278 units supplied at an average cost of 3.034*d*. per unit. From these figures it appears that London's total supply of electricity was 213,174,279 units, costing 2.839*d*. per unit.

TELEPHONE MATERIAL AND SUPPLIES FOR AUSTRALIA—Tenders will be received by the Deputy Postmaster-General, Melbourne, Australia, up to May 26, for supplying the following telephone material required by the Postmaster-General's department at Melbourne: (1) apparatus for exchange, one common battery switchboard of thirty sections in all, together with all associated frames, racks, power plant and parts; (2) apparatus for subscribers' premises, 3,000 telephone wall sets, 1,000 telephone table sets, 150 extension switches complete, seventy switchboards for two and six lines, fifty switchboards for three and ten lines, ten switchboards for six and twenty lines, ten switchboards for eight and fifty lines, 200 telephone wall sets and 100 telephone table sets for party lines. Interested parties may obtain specifications and tender forms from the office of the Deputy Postmaster-General, Melbourne, or the Commonwealth Offices, 72 Victoria street, London, S. W., England.

NEW COLORADO ELECTRIC COMPANY—Colorado Springs and Denver men, anticipating the development that will come to the Grand Valley with the progress of the government project to construct the high line canal which will irrigate close to 100,000 acres of land, have incorporated and partially financed a company with $1,500,000 capital to construct an electric railway from Debeque to Fruita, a distance of forty miles, and to build a power plant on the Grand River from which the electric current will be supplied. In addition, an irrigation system is being laid out to reclaim 20,000 acres of land. The whole is expected to cost the full $1,500,000. The incorporators and officers are: Horace K. Devereaux, of Colorado Springs, president; J. Arthur Connell, president Colorado Title and Trust Company, vice-president; Orson Adams, cashier Mesa County National Bank; E. A. Sunderlin, treasurer of the Arkansas, Louisiana & Gulf Railway, secretary and treasurer. The power plant is the first part of the project to be completed. Active work has already begun. The site is on the river near Debeque. Its total cost is estimated at $600,000, and 6,656 horsepower will be developed. There will be a dam in the river, a short canal and the power-house. The system is not expected to compete with the Central Colorado company which is above Glenwood Springs, more than fifty miles east. All the power will be needed to operate the company's own electric system and to pump the water for the 20,000 acres it is expected to irrigate.

NEW INCORPORATIONS.

NASHVILLE, TENN.—People's Co-operative Telephone and Switchboard Company, of Clay County. $2,000.

KNOXVILLE, TENN.—Knoxville Power Company. An amendment increasing the capital stock from $100,000 to $150,000.

DALLAS, TEX.—North Electric Company, of Dallas. $10,000. Incorporators: A. A. Mans, L. J. Weaver and George C. Steele.

SPRINGFIELD, ILL.—United Light and Power Company. $60,000. Incorporators: W. H. Downing, D. Downing, E. Burke, Moline.

SPRINGFIELD, ILL.—Calhoun Farmers' Co-operative Telephone Company. $25,000. Incorporators: C. D. Hunter, F. F. Bennett, M. H. Barnes, C. Temple Hardin.

COLORADO SPRINGS, COL.—The San Luis Valley Irrigation, Land and Power Company. Amended articles of incorporation increasing its capital from $1,000,000 to $1,300,000.

AUGUSTA, ME.—Citizens' Telephone and Telegraph Company, South Paris. To operate a telephone system in the towns of Paris and Norway. $1,225. President, John F. Plummer; treasurer, Charles W. Bowker, both of South Paris.

ENGINEERING SOCIETY NOTE.

MICHIGAN AGRICULTURAL COLLEGE—An engineering society has been organized among the students of the departments of civil, mechanical and electrical engineering at Michigan Agricultural College, East Lansing, Mich. It is the purpose of the organization to hold weekly meetings and have papers read on engineering subjects. The speakers will be chosen, as far as possible, from the college teaching force, and prominent engineers who are engaged in practical work will also present papers.

ELECTRIC LIGHTING.

MARIANNA, ARK.—Marshall Hewitt has purchased the plant of the Marianna Light and Power Company, owned by J. A. Plummer.

LEOMINSTER, MASS.—The Connecticut River Power Company has obtained a right of way through the southwestern part of the town.

HILLMAN, MICH.—Fire destroyed the electric light plant at Hillman on February 12. The plant was owned by Paul Elowski, of Alpena, Mich.

DENVER, COL.—The Northern Colorado Power Company has commenced the construction of an electric power line up Middle Boulder Cañon. The line will be six and one-half miles long.

EAU CLAIRE, WIS.—At Altoona, a suburb of this city, but incorporated as a city, municipal ownership of the lighting system has proven a failure. The city five years ago had the plant put in at a cost of $7,000.

COTTAGE GROVE, ORE.—C. F. Cunningham, business manager for the Willamette Valley Company at Eugene, has bought a half interest from A. Welch in the Cottage Grove Electric Company. Mr. Cunningham will act as manager of the plant.

MOSS POINT, MISS.—At a recent meeting of the mayor and board of aldermen a franchise was granted to the L. N. Dantzler Lumber Company for twenty-five years, giving it the right to erect and maintain an electric lighting plant in this place. The machinery has already been received.

WINCHESTER, ILL.—The Winchester Electric Light Company has entered into a contract with the Whitehall Light, Heat and Power Company to take its power from said company in the future. The contract stipulates that the Whitehall company must have its line ready for operation by July 1 of this year.

SHERMAN, TEX.—The city of Sherman is contemplating enlarging its municipal lighting plant from its present capacity of eighty arc lamps to 200 arc lamps. A direct-current series arc system is operated at present, and the plant merely supplies the street lighting.

NEW BEDFORD, MASS.—A proposition for the establishment of an independent lighting plant is being agitated among the merchants who would be prospective customers if such a company were formed. It is claimed for the proposed undertaking that electricity could be furnished at a greatly reduced rate.

NEWARK, N. Y.—The citizens of Newark are interested in a new proposition to furnish the village with electric lights, the power to be generated at a mill on the Canandaigua outlet, four miles southwest. The taxpayers are now paying $85 per lamp for street lighting. The contract will expire in about a year.

NEW HAVEN, CT.—Orders have been placed by the United Illuminating Company, of this city, with the Westinghouse Electric and Manufacturing Company for a large extension to its electric lighting plant in George street. This improvement will enlarge the incandescent light service in the residential sections of the city.

OROVILLE, CAL.—Interests connected with the Northern California Power Company are said to be planning two large power plants to be built in the Mooretown district on what is known as Fall River. For one of the plants, 2,000 inches of water with a fall of 1,000 feet is available, and for the other a fall of 500 feet with 1,500 inches of water.

LITTLE ROCK, ARK.—With the removal of the municipal electric light plant to new quarters it is the purpose of the city to greatly increase the capacity and efficiency. It is the present plan to double the size of the plant by providing for an aggregate of 700 lights. The estimated additions and improvements will cost in the neighborhood of $40,000.

GRANTS PASS, ORE.—There has been filed in the office of the clerk of Josephine County a mortgage from the Rogue River Electric Company to the Guarantee Trust Company of New York. The obligation represents a value of $700,000, as security for a bond issue for the Rogue River Electric Company, which has large holdings in Josephine and Jackson counties. This corporation is the outgrowth of the Condor Water and Power Company and several other minor enterprises.

RICHMOND, VA.—Edward W. Trafford, a consulting engineer of this city, has submitted to the council committees on water and electricity a proposition to prepare complete detailed drawings for a municipal electric light plant on the site of the old pump-house, with surveys and maps of the river and water power of the city. The plans are to include a power line to the new pump-house, the installation of electrical pumps at that point and a complete system of poles and wires for street lighting, covering the entire city.

REDDING, CAL.—At a meeting of the directors of the Northern Light and Power Company reports on the progress of the enterprise were received. On the recent trip of President A. F. Smith and Secretary A. W. Smith to San Francisco materials for the pipe line, the electric generating and the hydraulic machinery for the Cow Creek plant were ordered, to be shipped in June and July, and it is promised that the plant will be ready for business either in September or by the first of October. The initial installation will be 2,000 horse-power.

DAYTON, OHIO—According to the plans of the finance committee of council and the city solicitor, the interest on the public funds for the next six months will be turned into the light fund because of the financial condition of the service board. At the meeting of council an ordinance appropriating the interest money from January 1, 1908, until July 1, 1908, was put through its second and third readings and passed. It is figured that in this way $10,000 can be raised for lighting purposes. Of the $45,000 which was appropriated for the light fund by council, only $27,000 is to be found in available money. The report of the committee showed that if no relief were afforded, 150 electric lights and 450 gas lights would have to be extinguished.

HELENA, MONT.—M. H. Gerry, general manager of the Helena Power Transmission Company, announces that all financial arrangements have been completed for the building of the third dam across the Missouri River near here. A large force of men will be put at work immediately. It is estimated that it will take twenty-one months to complete the dam, which will generate upward of 50,000 horse-power. This will be utilized in the reclamation of the Prickly Pear Valley below Helena by forcing water over an area of 30,000 acres as well as in the Butte mines. The new dam will cost upward of $1,500,000. Practically the same interests which built the first two dams are behind the third. Chief among these is the estate of former Mayor Hewitt, of New York.

ALBANY, N. Y.—The Public Service Commission, Second District, has formally approved the action of the former state commission of gas and electricity on June 28 last in approving the merger by the Utica Gas and Electric Company of the Herkimer County Light and Power Company, Glens Falls Gas and Electric Company, Consolidated Light and Power Company of Whitehall and fifty-one per cent of the United Gas, Electric Light and Fuel Company of Sandy Hill and Fort Edward. Under the original order a bond issue of $2,000,000 was arranged, to be dated July 1. The order of the Public Service Commission was made necessary by request of bond purchasers, who questioned the validity of the issue because the mortgage was not recorded until July 1, the day when the state commission of gas and electricity went out of office.

PROVIDENCE, R. I.—At the annual meeting of the stockholders, held in Providence, Arthur L. Kelley, president of the Mechanical Fabric Company, of Providence, and first vice-president of the Providence Board of Trade, was elected the president of the Narragansett Electric Lighting Company. The other officers elected were Arthur H. Watson, vice-president; Edwin A. Barrows, secretary and treasurer, and an executive committee consisting of the president, *ex officio*, Fenner H. Peckham, Samuel P. Colt, William W. Douglas, Howard O. Sturges and Stephen O. Metcalf. The complete list of the board of directors is as follows: James M. Ripley, Fenner H. Peckham, William W. Douglas, D. A. Peirce, William A. Walton, Arthur H. Watson, George L. Shepley, H. Martin Brown, Samuel P. Colt, Howard O. Sturges, Samuel M. Nicholson, Robert W. Taft, Arthur L. Kelley, Stephen O. Metcalf and Jesse Metcalf. Arthur B. Lisle, of the firm of D. A. Peirce & Company, bankers and brokers, was elected general manager of the Narragansett Electric Lighting Company at a meeting of the board of directors on February 25.

ELECTRIC RAILWAYS.

SYRACUSE, N. Y.—Former Lieutenant-Governor William M. Brown, of Newcastle, Pa., has disposed of all his interests in the Syracuse & South Bay Electric Railroad Company to Clifford D. Beebe, who is at the head of the group of capitalists which controls the road.

WALLA WALLA, WASH.—Application for a franchise for the Washington & Oregon Traction Company will be made to the county commissioners April 6. The construction of a line into the Blue Mountains and also to tap much of the rich farm land of this section is planned.

GAINESVILLE, TEX.—It is expected that work will begin shortly on the proposed Gainesville, Whitesboro & Sherman Interurban Railway. Chicago capitalists are slated to be behind the project, and recently inspected the proposed route in company with Vice-President John King.

SAN FRANCISCO, CAL.—The San Francisco & Bay Counties Railway has been incorporated. Its purpose is to extend the electric sytsem to San José, thus providing an electric line from the Santa Clara county seat to San Francisco by way of Oakland. The leading director is F. M. Smith.

PEORIA, ILL.—The Illinois Traction system has signed a contract with the United States Express Company whereby the Interurban is to carry all express matter for that company to cities and towns reached by the electric road. The new contract goes into effect April 1, and it is thought that its fulfilment will necessitate an increase in the rolling stock.

OKLAHOMA CITY, OKLA.—The corporation organized some time ago to build an interurban electric line between this city and Shawnee, El Reno and several other towns, covering some 500 miles, has been revived and, according to statements of those connected with the enterprise, grading on the line between this city and Shawnee will be commenced within the next few months.

GREENVILLE, PA.—State Senator James M. Campbell, of Mercer, representing a company which proposes to construct a trolley line connecting Greenville, Mercer and Sharon, has asked the Greenville council for a franchise covering the streets of the borough. Senator Campbell asserted the line would be built and the first link in the chain would be the Greenville line, followed by a line connecting Sharon and Mercer.

SHELBYVILLE, IND.—At a meeting of the city council the franchise which has been held by the Capital City Circuit Traction Company was forfeited. The franchise was given the company two years ago and, according to the terms, the company was to commence work on the line by February 20, 1908, at the latest. The council also gave the company the right to use any of the streets in the city. It is understood that another franchise will be asked for.

BABYLON, N. Y.—The South Shore Traction Company has accepted the franchise granted it by the town board and board of highway commissioners some weeks ago. The franchise is for ninety-nine years, and after the first twenty the company pays a small bonus to the town until 1957. After that period the company is required to pay into the town treasury three per cent of its gross receipts. It is understood that the work of construction between Babylon and Amityville will commence soon.

NEW YORK, N. Y.—The Public Service Commission has authorized the issue of $30,000 of bonds of the Coney Island & Brooklyn Railroad Company. The bonds will cover the cost of ten new cars for use on the Smith street line. The commission also authorized the Interborough Rapid Transit Company to include in its original cost of construction approximately $190,000 of four-per-cent city bonds to be used to settle damage claims arising at the time the Park avenue subway tunnel was changed to the east side of the street.

BURLINGTON, IOWA—At a meeting of the stockholders of the Burlington-Bonaparte Electric Railway the following board of directors was elected: J. A. Johnson, H. H. Meek, A. G. Roberts, D. Cresap, all of Bonaparte; T. J. Lampe, of West Point; John Blaul, Luke Palmer, C. C. Paule, W. E. Blake, all of Burlington. The directors elected the following officers: President, J. A. Johnson, of Bonaparte; treasurer, H. H. Meek, of Bonaparte; first vice-president, John Blaul, of Burlington; second vice-president, T. J. Lampe, of West Point; secretary, Edward E. Egan, of Burlington.

CINCINNATI, OHIO—The annual meetings of the Cincinnati Traction Company, Ohio Traction Company, Ohio Electric Railway, Cincinnati Northern Traction Company, Indiana, Columbus & Eastern Company, Cincinnati Car Company, Southern Ohio Express Company and the Columbus, Newark & Zanesville Traction Company were held February 10. F. A. Healy succeeds George Warrington as director in the Southern Ohio Express Company. Mr. Healy also succeeds Walter Draper as secretary in the company. With that exception there were no other changes, all the other directors being re-elected.

CARMI, ILL.—Capitalists from Evansville, Cynthiana, Mount Carmel, Lancaster and Olney, interested in the building of an electric line from Evansville to Olney, Ill., met at Grayville and decided to incorporate the Evansville, Mount Carmel & Olney Interurban Company under the laws of Indiana. Aden Knopp, of Olney, is president, and G. W. Courter, Mount Carmel, was appointed secretary. The following directors were elected: C. J. Seibert, E. O. Lockyear, Jacob Laubscher, Evansville; E. B. Bixley, Thomas Newell, Cynthiana; J. O. Smith, J. F. Seibert, Lancaster; Aden Knopp, J. F. Hyatt, F. N. Boyer, Olney.

BIRMINGHAM, ALA.—At the annual meeting of stockholders of the Birmingham Railway, Light and Power Company Lee C. Bradley and Harry C. Falk were elected directors, succeeding, respectively, J. A. Emery and Gordon Abbott, resigned. The customary reports of officers were received and the following directors were named: Col. T. G. Bush, Dr. F. D. Nabers, B. F. Roden, R. H. Pearson, Lee C. Bradley, W. P. G. Harding, M. V. Joseph, Robert Jemison, G. B. McCormick, W. H. Kettig, B. F. Moore and A. H. Ford, all of Birmingham; Harry C. Falk, J. R. Newman and Sidney H. March, all of New York; William Madison Smith and George H. Davis, both of New Orleans. Immediately after the stockholders' meeting the directors met and named the following officers: A. H. Ford, president and general manager; Lee C. Bradley and George H. Davis, vice-presidents; E. M. Cory, treasurer and auditor; E. C. Jolly, assistant treasurer and auditor; J. P. Ross, secretary.

EDUCATIONAL NOTES.

OHIO STATE UNIVERSITY—The Ohio State University has published, in a supplement to Bulletin No. 2, two addresses recently delivered by Professor William T. Magruder, dealing with industrial education. The first of these is entitled, "Present Status of Technical Education in Ohio." This is the presidential address delivered before the Ohio Society of Mechanical, Electrical and Steam Engineers, November 16, 1906. The other is, "Some Suggestions on Industrial Education in Ohio." This is the presidential address delivered before the same society November 15, 1907.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The Massachusetts Institute of Technology has published in the bulletin for January, 1908, the reports of the president and other officers of the institution. These reports indicate that the school is in a flourishing condition and is growing steadily. There are this year twelve more instructors than last year, and the students enrolled are something over fourteen hundred. Professor D. C. Jackson, head of the department of electrical engineering, discusses briefly the good effect of the changes in the course which are being instituted there. He says that the growth of the department is such that it already needs additional room.

DATES AHEAD.

Iowa Independent Telephone Association. Annual meeting, Cedar Rapids, Iowa, March.

Ohio Independent Telephone Association. Annual meeting, Columbus, Ohio, March 19.

Nebraska Electrical Association. Annual meeting, Omaha, Neb., April 15-16.

Iowa Electrical Association. Annual meeting, Des Moines, Iowa, April 22-23.

Iowa Street and Interurban Railway Association. Annual meeting, Des Moines, Iowa, April 24.

West Virginia Independent Telephone Association. Annual meeting, Fairmont, W. Va., May 7-9.

Railway Signal Association. Next meeting, New York city, May 12.

National Electric Light Association. Annual meeting, Chicago, Ill., May 19-22.

Telephone Association of Texas and Louisiana. Annual meeting, Dallas, Tex., May 25-27.

PERSONAL MENTION.

MR. ARTHUR WEST, formerly chief engineer of the Westinghouse Machine Company, severed his connection with that company on January 31.

MR. H. C. VAN NATTA has resigned as chief engineer of the Pueblo & Arkansas Valley Electric Railway Company, Pueblo, Col., and has been succeeded by D. L. MacAffree, of Denver.

MR. ROCKWOOD H. BULLOCK, superintendent of tracks of the Worcester (Mass.) Consolidated Street Railway Company, has resigned. He is succeeded by F. A. Wilkinson, hitherto assistant superintendent of tracks.

MR. L. R. POMEROY, for a number of years special representative of the General Electric Company's railway department, has resigned and on March 1 became assistant to the president of the Safety Car Heating and Lighting Company.

MR. FENWICK E. LOWE, superintendent of the St. Paul City Railway Company, St. Paul, Minn., has tendered his resignation, due to ill health. He will be succeeded by J. S. Tevier, who has been associated with the building of a number of electric lines.

MR. ALFRED COLLYER has been appointed district manager of Canada sales of the Wagner Electric Manufacturing Company, St. Louis, Mo., with offices in the Bell Telephone Building, Montreal, Quebec. Mr. Collyer's title will be sales manager for Canada.

MR. WILLIS G. MELOON, general manager of the Atlanta Shore Line Railway Company, with headquarters at Portsmouth, N. H., has resigned to accept a similar position with the present owners of the road, A. H. Bickmore & Company, New York city, in the South or West. He is succeeded by E. B. Kirk, of Dixon, Ill.

DR. LEE DE FOREST, the well-known inventor, was married on Tuesday, February 28, in New York city, to Miss Nora Stanton Blatch. Dr. de Forest and his bride will spend several months traveling abroad, where they intend to visit the laboratories of a number of the famous technical institutions.

MR. J. P. CLARK has been made manager of the Michigan United Railways Company. Mr. Clark formerly managed the electric lines of the Jackson Consolidated Traction Company, at Jackson, Mich., and between Jackson and Detroit, and has had a wide experience in the electric railway field.

MR. HENRY L. DOHERTY will address the members of the Rockford (Ill.) Manufacturers and Shippers' Association at the annual business meeting, to be held on March 21. Mr. Doherty is president of the American Gas and Electric Company, which owns, among a large number of other public service companies, the Rockford Edison Company.

MR. J. C. MOULTON, for the past six years with the New York office of the Fort Wayne Electric Works, has accepted a position with the Manhattan Electrical Supply Company as special representative. Mr. Moulton's experience in all branches of the electrical business dates back to 1889. His large acquaintance with the trade in general should prove of great value in his new connection.

MR. CHARLES N. HUGGINS, secretary of the Portland (Ore.) Railway, Light and Power Company, will assume the duties of S. G. Reed, treasurer, who resigned recently to accept the presidency of the German-American Bank. The offices of secretary and treasurer will be consolidated. Mr. Reed, although no longer treasurer of the electric company, will retain his position as a director of the concern.

MR. WALTER L. BYRON, advertising manager of the Union Gas and Electric Company, Cincinnati, Ohio, has resigned, and that department of the company is discontinued as the result of an order issued by the executive committee. The scope of the new-business department will be enlarged. The advertising department was inaugurated when the Union company took over the local property.

MR. CHARLES L. ROGERS, of Uxbridge, Mass., superintendent of the Uxbridge & Blackstone Street Railway Company, will hereafter be in charge of the Milford, Attleboro & Woonsocket Street Railway in addition to his present duties. Ernest A. Potter, who has been superintendent of the Milford, Attleboro & Woonsocket Railway, has been released from the employ of the company. He was in the company's service many years.

DR. JOHN B. WHITEHEAD, of the Johns Hopkins University, Baltimore, Md., announces that he is prepared to undertake consulting electrical engineering work, including designs, estimates, specifications, tests, railway lighting and power projects. Dr. Whitehead is a graduate of the university, and after taking the electrical engineering course there, served for some years with the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. He left the latter company to accept a position as lecturer on applied electricity at the Johns Hopkins University, and is now in charge of this work there.

ELECTRICAL SECURITIES.

The first real semblance of a better feeling crept into the market last week as a result of the stimulus given by the apparent improvement in business conditions generally. While the percentage increases are based on very low figures, still the month of February shows a real gain over January and December. This improvement, while not great, will undoubtedly be continued, as it is because very conservative interests are realizing that there is safety in going ahead and have determined to meet the demand on the ground rather than wait until satisfied beyond all reasonable doubt as to the efficacy of preparing now to gather the golden harvest which is bound to follow. The tonnage of steel rails, while not enormous, is improving, and this at prices which were acceptable in boom times. The agricultural section is prosperous and will not be backward in investing in public improvements when satisfied that these will be properly safeguarded, and the climatic disturbances, while distressing to those of the cities, have furnished the farmer with a blanket of snow which assures him a good soil and bountiful crops in response to the coming spring planting.

Dividends have been declared upon the following electrical securities: Wilkes-Barre (Pa.) Gas and Electric Company; a dividend of 1 per cent on the capital stock, payable April 1, as registered March 24. The payment of the dividend on April 1 is in accordance with the desire of the stockholders for quarterly, instead of semi-annual declarations, as heretofore.

ELECTRICAL SECURITIES FOR THE WEEK ENDED FEBRUARY 29.

New York:	*Closing.*
Allis-Chalmers common	5½
Allis-Chalmers preferred	17½
Brooklyn Rapid Transit	40
Consolidated Gas	98½
General Electric	115
Interborough-Metropolitan common	7¼
Interborough-Metropolitan preferred	19¼
Kings County Electric	90
Mackay Companies (Postal Telegraph and Cables) common	52¼
Mackay Companies (Postal Telegraph and Cables) preferred	60
Manhattan Elevated	120
Metropolitan Street Railway	15
New York & New Jersey Telephone	98
Western Union	46½
Westinghouse Manufacturing Company	39½

Directors of the Mackay Companies have declared the regular quarterly dividend of 1 per cent on both the common and preferred stocks, payable April 1 to stockholders of record March 14. Books close March 14, and reopen March 19.

Boston:	*Closing.*
American Telephone and Telegraph	106½
Edison Electric Illuminating	204
Massachusetts Electric	40
New England Telephone	106
Western Telephone and Telegraph preferred	50
Philadelphia:	*Closing.*
Electric Company of America	8¾
Electric Storage Battery common	26
Electric Storage Battery preferred	26
Philadelphia Electric	5¾
Philadelphia Rapid Transit	14¼
United Gas Improvement	75¾

The annual meeting of the Electric Storage Battery Company will be held March 18 in Camden, N. J.

Chicago:	*Closing.*
Chicago Telephone	107
Commonwealth Edison	84¾
Metropolitan Elevated preferred	45
National Carbon common	50¼
National Carbon preferred	100

TELEPHONE AND TELEGRAPH.

CHESAW, WASH.—Wires for the telephone line built between Chesaw and Kipling by the Independent Rural Telephone Company are being strung into Chesaw and it is expected the service will be opened in a short time.

WAVERLY, WASH.—The Waverly-Fairfield Telephone Company at its annual meeting decided to put in a metallic circuit. These officers were elected: President, James Hays; secretary, A. L. Robinson; treasurer, James Lodge.

HARTFORD, CT.—The Home Telephone Company, capitalized at $1,000,000, has been launched by filing articles of incorporation at Hartford. It has divided the state into seventeen divisions and, it is announced, already has contracts for 8,000 subscribers.

GRANGEVILLE, IDA.—The White Bird-Pittsburg Mutual Telephone Company has been organized at Grangeville to operate a telephone line between White Bird and Pittsburg. The line will cross the Salmon River at Remingtons ferry, and then lead across the high divide between the Salmon and Snake rivers. The head office of the company will be at White Bird.

WENATCHEE, WASH.—Thirty thousand dollars' worth of bonds have been sold by the Farmers' Telephone Company, for the purpose of extending the line to Leavenworth. The company was organized several years ago by ranchers, who have control of the entire system in the Wenatchee Valley. There are nearly 1,000 instruments installed and the company expects to put in 500 more this year.

WHITEFISH, MONT.—Carl Green is negotiating for the purchase of the Grinnell-Edwards telephone franchise at Whitefish, and the town council will vote on the amended proposition at a meeting in April. The amendments desired change the length of life of the franchise from fifty to twenty-five years, and provide a clause allowing the city to step in and operate the system in case it should be shut down at any time by a strike. Mr. Green says the plant with 100 instruments can be installed in ninety days.

DENVER, COL.—The annual statement of the Colorado Telephone Company, operating in Colorado and New Mexico, for the year ended December 31, 1907, shows net earnings for dividends of $757,599, equal to 9.2 per cent on $8,209,050 capital stock, compared with $411,534, or 6.3 per cent, on $7,000,000 stock for the 1906 year. The income account is as follows: Gross, $2,514,366; expenses, $1,756,767; net, $757,599. Subscribers' stations increased 10,782, or nineteen per cent, during the year. Construction expenditures aggregated $921,908, and $1,209,050 additional stock was issued.

SPOKANE, WASH.—A fifteen per cent dividend on a capital stock of $15,000 was declared by the Inland Co-Operative Telephone Association at its annual meeting at Pullman, Wash. These officers were elected: President, J. C. Farr; secretary, J. S. Klengard. Directors: M. W. Whitlow, L. W. Robinson, R. G. Lyle, R. E. Largent and G. H. Lennox. The company owns a system extending through the rural districts, with connections at Pullman, Albion and Colfax, and switching arrangements with the Pacific Telephone and Telegraph Company. The company is composed largely of farmers, who built the line, beginning with a barbed-wire fence system with four instruments. This has been changed to overhead lines and 300 instruments, distributed in various parts of the Palouse wheat belt.

LEWISTON, WASH.—Preliminary plans already prepared indicate that the Interstate Telephone Company will install a modern telephone system in Lewiston and Clarkson next summer. The Interstate has been delayed because of the difficulty in selling bonds, but resumption of work is expected in a short time. The company will spend $50,000 on an exchange at Lewiston, which will have a capacity of 400 instruments. In the down-town streets the wires will be carried in underground cables. The line will carry, besides a local exchange, a long-distance service connecting in Spokane with the Home Telephone Company. The long-distance wires will be on a copper metallic circuit. The plans now in view contemplate an expenditure of $35,000 in Moscow. The company is building from Spokane, the present terminus now being at a point near Rockford, Wash.

NEW PUBLICATIONS.

MINUTES AND REPORTS OF THE BOARDS OF COMMISSIONERS OF ELECTRICAL SUBWAYS IN THE CITY OF BROOKLYN—The minutes and reports of the boards of commissioners of electrical subways in the city of Brooklyn, being the records from 1885 to 1889, and from 1892 to 1896, have been published in book form.

REPORT OF THE COMMISSIONER OF EDUCATION—Vol. ii of the report of the Commissioner of Education to the Secretary of the Interior, Washington, D. C., for the year 1906, has been issued. This contains reports of the normal and secondary schools, manual and industrials, commercial and business and nurse-training schools, schools for the colored race, reform schools, and schools for the defective classes. A summary of the legislation relating to education enacted by the Fifty-ninth Congress is given, and a report upon compulsory school attendance.

INDUSTRIAL ITEMS.

THE H. KRANTZ MANUFACTURING COMPANY, 160-166 Seventh street, Brooklyn, N. Y., has published in bulletin No. 17 a description of its new springless ceiling switches.

THE WEBER GAS ENGINE COMPANY, Kansas City, Mo., has issued brochure No. 56, which demonstrates the applicability of the Weber gas engine for driving generators in central stations.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has ready for distribution its bulletin No. 63, devoted to "The Standard" direct and alternating-current ceiling, bracket, desk and exhaust fans.

THE SCHUTTE & KOERTING COMPANY, Philadelphia, Pa., has ready for distribution some bulletins devoted to water jet eductors, ash conveyers, and the Koerting patent oil-firing system with centrifugal spray nozzles.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, Waverly Park, Newark, N. J., has ready for distribution several bulletins devoted to its direct-current switchboard voltmeters and ammeters, and alternating-current voltmeters, ammeters and milammeters.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., in the March issue of "Graphite," publishes an interesting article on wire-rope dressing. There are also a number of other interesting contributions and sketches bearing on the subject of graphite lubricants and weather-proofing pigments.

THE F. D. LAWRENCE ELECTRIC COMPANY, Cincinnati, Ohio, announces that the recent fire at its establishment was not of such a character as to cause any interference in the usual conduct of its business. The company will continue to fill orders from its offices at 219 West Fourth street, Cincinnati.

THE SIMPLEX COMPANY, Newark, N. J., manufacturer of electrical measuring instruments, has been succeeded by the Standard Instrument Company. The new company will continue to make the Simplex suspension type voltmeters and ammeters and has completed its line of alternating and direct-current instruments. A new catalogue will be issued shortly.

WARREN WEBSTER & COMPANY, Camden, N. J., have published a very interesting and attractive catalogue devoted to the Webster system of steam circulation for heating purposes. This catalogue contains information which is of great value to engineers, as the problems which this system solves enter very largely into construction in all parts of the country.

THE WESTERN ELECTRIC COMPANY, 259 South Clinton street, Chicago, Ill., in bulletin No. 5,352, describes and illustrates its line of fan motors for 1908. This catalogue is very handsomely printed, and in addition to illustrating the various types of desk, bracket and ceiling fans, the text gives a very satisfactory description of the size and output of each piece of apparatus.

THE ELECTRIC MACHINERY COMPANY, Minneapolis, Minn., announces that Arthur B. Shepard will represent it in northern Ohio. Mr. Shepard has been with the General Electric Company for a number of years, for the past seven years having been manager of the company's Cleveland (Ohio) office. Before that time he was designing engineer with the General Electric Company, at Schenec-

tady, N. Y. Mr. Shepard will make his headquarters at 1207 New England Building, Cleveland.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., has issued an interesting booklet entitled "Where Many Knife Switches Fail." This article appeared in the January issue of "Trumbull Cheer." The text is devoted to an analysis of the faults which occur usually in knife switches, and indicates where these have been eliminated in the switch which the Trumbull company is placing on the market.

THE GERMANIA ELECTRIC LAMP COMPANY, Harrison, N. J., has been running full time for some months. January was the best month that this company has ever had, as it did forty to fifty per cent more business than in January of last year. February shipments were also much greater than those of a year ago. The company has increased its factory facilities in many directions and has a greater force of employés now than at any other time.

THE MEAD-MORRISON MANUFACTURING COMPANY, Cambridgeport, Mass., is distributing a fine catalogue devoted to modern hoisting engines for coal wharves, quarries, railroads, dock and bridge construction; mines, suspension cableways, structural work, dredging, hauling, conveying and driving. The company also makes automatic coal-handling machinery, cableways, and complete hoisting plants equipped with either steam or electrical apparatus for driving.

THE MURRAY IRON WORKS COMPANY, Burlington, Iowa, builder of engines, boilers and complete power plants, has published a very handsome catalogue devoted to its safety water-tube boilers. This catalogue is replete with fine illustrations of various sections of the boiler equipment and photographic reproductions of some of the more prominent buildings where these boilers have been installed. The text is devoted to a general description of the boilers and an analysis of the physical construction of the various elements entering into the design.

DOSSERT & COMPANY, New York city, have received what is probably the largest order for terminal lugs ever used on a single installation in this country. The material is for use in the wiring of the terminal buildings at Cortlandt, Church and Fulton streets, New York city, of the Hudson & Manhattan Railroad Company, operating the tunnels under the Hudson River which have just been opened to the public. These terminals are all of the Dossert solderless type, comprising front connection, back connection, angle and swivel lugs, and range in size from 2,000,000 circular mils down to No. 4 cable. Part of the order comes from the Westinghouse Electric and Manufacturing Company, and is for lugs to be used on its fuse blocks of the enclosed type, sixty-one to 600 amperes. Approximately 1,000 Dossert solderless lugs are required for the switchboards and panel-boards of these buildings. These solderless terminal lugs will also be furnished for the switchboards now being manufactured by E. C. Tibbals & Company for the new building of the Brooklyn Academy of Music.

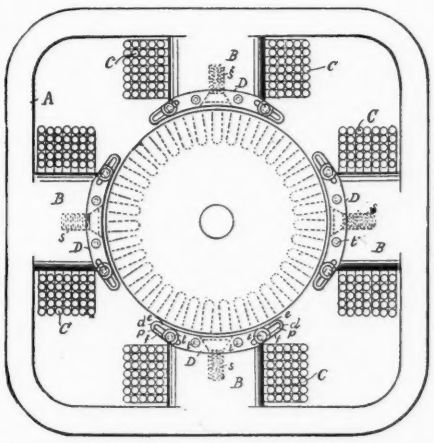
THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued a beautifully printed catalogue devoted to its fan motors for 1908. The 1908 motors are plainer and more simple, if possible, than those of previous design, but possess the same high degree of efficiency, speed, control and reliability. The distinguishing feature in connection with the direct-current desk motors is the universal joint, by means of which a desk motor may be instantly transformed into one of the wall-bracket type, or *vice versa*, without the aid of tools. The company has also issued a handsome booklet, known as Bulletin No. 4,548, illustrating typical examples of direct and alternating-current motors installed on a great variety of lathes, drills, grinders, punches, shears, boring mills and similar tools. Among the advantages gained, as pointed out in the bulletin, are general economy of power and increased production, ease of control and convenience of handling, better arrangement of tools, independence of environment, greater cleanliness and decreased cost of maintenance, with increased safety to employés.

Record of Electrical Patents.

Week of February 25.

879,879. ELECTROMAGNETIC PIANO PLAYER. Wesley B. Kraft, Milan, Kan. The lever hammers are operated by electromagnets.

879,885. INTERLOCKING RELAY. Edward McClintock, St. Paul, Minn. A relay in a normally open circuit, which is operated by the passing of a train.



879,927.—POLE-SHOE FOR DYNAMOELECTRIC MACHINES.

879,886. HIGHWAY-CROSSING SIGNAL FOR ELECTRIC ROADS. Edward McClintock, St. Paul, Minn. The line circuit of a signal is closed by the passage of a train.

879,887. METHOD OF REGULATING ELECTRIC GENERATORS. George S. Neeley, St. Louis, Mo. The resistance in the field of the exciter is controlled by two electromagnets; one connected in the main field circuit, and one in the exciter field circuit.

879,913. PREPAYMENT ARRANGEMENT FOR METERS. Henry W. Sayles, Peoria, Ill., assignor, by mesne assignments, to George M. Willis, Chicago, Ill. The prepayment mechanism is controlled by an electromagnet in the main pressure circuit of the meter.

879,924. ELECTRICAL APPLIANCE FOR CLOCKS. Harry O. Swedberg and Amos T. Durbin, Rossville, Ill. A time system for a plurality of signals.

879,927. POLE-SHOE FOR DYNAMOELECTRIC MACHINES. Robert B. Treat, Newark, N. J., assignor to Crocker-Wheeler Company, Ampere, N. J. The shoe is provided with adjustable pole-tips.

879,940. GROUND-CONNECTION CLAMP. William H. Blood, Jr., Wellesley, Mass. A hinged clamp.

879,941. WIRE SPLICE OR COUPLING. Ira M. Botkin, Carlos, Ind. The wires are inserted through the body of the splice and tied.

879,943. TROLLEY-POLE SUPPORT. James L. Chase, Ayer, Mass., assignor of one-half to Ralph J. Joslin, Webster, Mass. A pivotally mounted trolley pole controlled by a weight.

879,949. COIL-RETAINER FOR DYNAMOELECTRIC MACHINES. Gano Dunn, East Orange, N. J., assignor to Crocker-Wheeler Company, Ampere, N. J. A coil-retainer is passed into the slot and locked by rotation.

880,008. MAIL-POUCH RECEIVING AND DELIVERY APPARATUS FOR RAILWAY CARS. Chauncey W. Broughton, Carlton, Ill. The pouch is picked up by an electromagnet and dropped within the car.

880,011. DYNAMOELECTRIC MACHINE. Henry Chitty, Strand, London, England. The poles are provided with bridges and are slotted on one side to receive a coil.

880,021. TROLLEY. George H. Gross, Binghamton, N. Y. An annular contact piece sliding in a harp.

880,046. HIGH-FREQUENCY DISCHARGE APPARATUS. James E. Seeley, Los Angeles, Cal., assignor to Synchronous Static Company, Los Angeles, Cal. The induction coil has a number of windings which may be connected to the supply or the charging circuit.

880,055. ARC-LIGHT ELECTRODE CONTAINING METAL WITHIN THE SAME. Hermann Viertel, Charlottenburg, Germany, assignor to Gebrüder Siemens & Company, Charlottenburg, Germany. A reticulated metal tube filled with a core material.

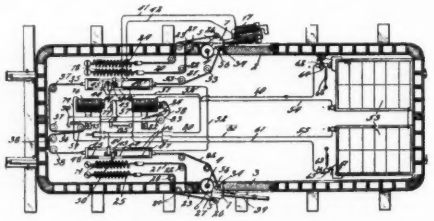
880,074. ELECTRICAL SYSTEM OF MEASURING TEMPERATURES. Ernst Haagn, Hanau, Germany, assignor to firm of W. C. Heraeus, Hanau, Germany. A resistance thermometer and bridge arrangement.

880,107. ELECTRIC TROLLEY. Leonard Smith, North Tonawanda, N. Y. The wheel is carried in a pivoted harp.

880,121. ELECTRICAL INSULATOR. Daniel G. Bolton, Camden, N. J. A group of bushings of flexible insulating material are placed around a pin.

880,136. SIGNAL SYSTEM. Julien A. Gehrung, New York, N. Y. A railway signal system controlled by currents of varying strength.

880,152. ELECTRIC SIGNAL FOR ELEVATORS. Charles E. Moore, Los Angeles, Cal. A drop signal system.



880,008.—Mail-Pouch Receiving and Delivery Apparatus for Railway Cars.

880,155. AUTOMATIC TELEPHONE ALARM. Milton L. Murdock and John C. Gallagher, Elmira, N. Y.; said Gallagher assignor to said Murdock. A signal box and means for closing the telephone circuit to which the signal is attached.

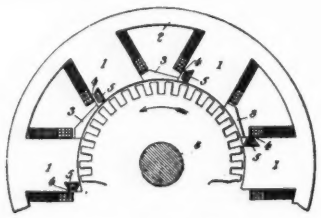
880,160. BURGLAR-ALARM SYSTEM AND APPARATUS THEREFOR. Milton R. Ney and Samuel S. Ullman, Washington, D. C. A system for attaching to a telephone circuit.

880,196. BATTERY. Frank A. Decker, Philadelphia, Pa., assignor, by mesne assignments, to Decker Electric Manufacturing Company, Wilmington, Del. Conduits are provided for circulating the electrolyte.

880,203. INSULATOR. John D. E. Duncan, Brooklyn, N. Y. A built-up insulator of the suspension type.

880,209. ELECTRICALLY OPERATED CLOCK. Harleigh Gillette, Chicago, Ill. A secondary clock system controlled by a master clock.

880,218. SIGNAL MECHANISM FOR BLOCK-SIGNAL SYSTEMS. Harry L. Johnson, Topeka, Kan. A system utilizing a group of relays each controlling a separate source of power.



880,011.—Dynamoelectric Machine.

880,249. ELECTROMAGNETIC BRAKE. Hiram Snodgrass, Oklahoma, Okla. A spring-operated brake controlled by a solenoid.

880,263. ELECTRIC SIGN. Ignatz Young, San Francisco, Cal. A revolvable sign.

880,266. ELECTROMAGNETIC CLUTCH. Heinrich Ast, Vienna, Austria-Hungary, assignor to the firm of Vulkan Maschinenfabriks Actien Gesellschaft, Vienna, Austria-Hungary. A friction clutch controlled electromagnetically.

880,271. METHOD OF FORMING RAIL BONDS, ETC. Eugene M. Bournonville, Jersey City, N. J. The bond head is fused to the rail.

880,272. THERMOELECTRICAL SYSTEM. William H. Bristol, New York, N. Y. A thermo-couple affected only by a sudden change in temperature.

880,273. INDICATING AND RECORDING SYSTEM. William H. Bristol, New York, N. Y. A recording resistance thermometer.

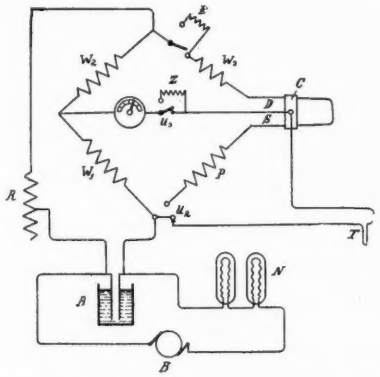
880,275. APPARATUS FOR PERFORATING FILLETS OF PAPER FOR THE AUTOMATIC TRANSMISSION OF MESSAGES, ETC. Charles L. Buckingham, New York, and Emil Germann, Brooklyn, N. Y.; said Germann assignor to said Buckingham. A machine for perforating strips for a rapid telegraphic system.

880,329. RAILWAY SIGNALING SYSTEM. Wilmer W. Salmon, Rochester, N. Y., assignor to General Railway Signal Company, Gates, N. Y. A system utilizing one rail of the track and a supplemental return conductor.

880,368. BATTERY. Frank A. Decker, Philadelphia, Pa., assignor, by mesne assignments, to Decker Electrical Manufacturing Company, Wilmington, Del. A battery with honeycombed electrodes.

880,395. TROLLEY-WHEEL SPRING. Ralph E. Noble, Chicago, Ill., assignor to Morgan-Gardner Electric Company, Chicago, Ill. Springs hold the wheel centrally within the harp.

880,398. ELECTROMECHANICAL SLOT FOR SIGNALS. George S. Pflasterer, Nashville, Tenn. An electromechanical interlocking device.



880,074.—Electrical System of Measuring Temperatures.

880,418. INSULATOR FOR HIGH-TENSION CONDUCTORS. Samuel H. Summerscales, Winnipeg, Manitoba, Canada. An insulator with shields for preventing surface leakage.

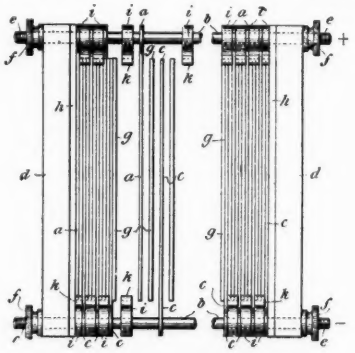
880,420. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. A battery of the Faure type with plates built up of metal strips.

880,421. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. The plates are constructed of interleaved metal strips separated by porous insulation.

880,422. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. The plates, built up of metal strip, are supported in an open insulated frame.

880,423. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. Porous retaining plates are held against the edges of the built-up battery plates.

880,424. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. A rigid grooved base for built-up battery plates.



880,421.—Storage-Battery Plate.

880,425. STORAGE-BATTERY PLATE. Alfred O. Tate, Toronto, Ontario, Canada, assignor to Tate Electrolytic Company of America. A hollow base plate with grooves for circulating the electrolyte.

880,429. COIL-RETAINER FOR DYNAMOELECTRIC MACHINES. Robert B. Treat, Newark, N. J., assignor to Crocker-Wheeler Company, Ampere, N. J. A retainer for inserting and expanding in the armature slots.

880,435. ELECTRIC ARC LAMP. Thomas E. Adams, Cleveland, Ohio. A cover for an enclosed arc lamp.

880,485. MAGNETO ELECTRIC INDUCTOR. Martin Fischer, Zurich, Switzerland, assignor to Actiengesellschaft "Magneta," Zurich, Switzerland. A soft iron armature rotating within a coil alternately reverses the magnetic flux.